

Continental
Airlines



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AUTHORIZATION PAGE

This Continental Airlines Flight Manual contains all the approved Airplane Flight Manual (AFM) operating procedures and performance data as revised and/or modified, and includes any appropriate data or information from revisions dated or numbered:

777-224 Revision #17 Dated 08/09/02

This manual meets or exceeds all requirements of the 777-224 approved Airplane Flight Manual in accordance with F.A.R. 121.141.

FLIGHT DECK DATA

The items listed below are provided on the flight deck for flight crew convenience. In the event a listed document is temporarily missing or unusable, operations may be continued using the source material from the applicable Flight, Operations, or Planning & Performance Manual. Missing or out of date documents should be replaced at a station where replacements are available.

B777-224

<u>ITEM</u>	<u>FORM NO.</u>	<u>DATE</u>
B777:		
AMT Taxi Checklist	47.0077	06/30/00
AMT Towing Checklist	47.0090	06/30/00
Data Link Communications Guide	24.6200	11/01/02
ECL Airline Database	3167-BFT-002-52	11/01/02
ETOPS/LRN Briefing Guide	24.6104	11/01/02
Non-Precision Approach Briefing Guide	24.3021	11/01/02
Normal Checklist	24.6102	11/01/02
Precision Monitored Approach Briefing Guide	24.6100	11/01/02
Conversion Tables	24.3020	11/01/01
Emergency Response Guide	ERG / Redbook	2001 / 2002
Jumpseat Rider Briefing Card	21.0020	07/01/94
Onboard Security Incident & Medlink Procedures Card	21.9016	01/01/02

Note: The Emergency Response Guide (ERG) or copies of the appropriate pages must be on board whenever hazardous materials are transported.

INTRODUCTION**GENERAL**

The purpose of this manual is to provide Continental Airlines flight crews with a document which serves both as a training aid and as an inflight tool for handling normal and non-normal situations.

Included in this introduction is an overview of the organization and procedures of Sections 1 through 5 and a detailed discussion of the standard formatting devices used in developing all normal and non-normal checklists.

Flight crews are expected to be familiar with these formatting devices and to be prepared to operate under these guidelines on the line and during simulator training.

CRM

Effective Crew Resource Management (CRM) can substantially improve safety in line operations. Technical proficiency, knowledge of aircraft systems and adherence to standard operating procedures continue as the foundation of aviation safety. Effective CRM should also help a crew achieve safe conclusion of the flight when non-normals or other problems occur. Continental Airlines is committed to fostering a high level of CRM skills. The practice of effective CRM is expected behavior among all crewmembers.

Pilots should routinely utilize effective CRM skills as discussed during the Thrust & Error Management (TEM) workshops. All crewmembers are expected to build strong CRM skills, so that each pilot can contribute fully during both normal and non-normal line operations. Industry studies have shown that most airline mishaps were attributable to poor CRM. Failure to follow standard operating procedures, failure of non-flying pilots to monitor the flying pilot, and unchallenged tactical decision errors by the Captain were the leading causes identified. Effective CRM would have broken the chain of events leading to an accident in the majority of mishaps studied.

Crew Effectiveness Markers

The following Crew Effectiveness Markers were developed to assist crewmembers in their understanding and practice of Crew Resource Management. The markers were structured in a checklist format for ease of use and recall. Crewmembers should use the markers as a checklist for decision making and as a guide for crew briefings. They should be reviewed periodically to improve CRM proficiency, just as emergency and non-normal checklists are revisited from time to time. CRM will be evaluated in training events, proficiency check, and line check utilizing the Crew Effectiveness Markers.

The Crew Effectiveness Markers can also serve as a debriefing tool after a line flight or training event. A debrief should always be conducted after a flight which challenged a crew in some manner. Potential exists for valuable new learning if a crew conducts a frank yet positive self-evaluation following significant flight events. Debriefings should be conducted by the Captain, but may be initiated by anyone in the crew. Frequent, open communications and active listening are consistently identified as key characteristics of the most effective flight crews.

Overall Technical Proficiency

- Set a professional example.
- Adhere to SOP, FAR's, sterile cockpit, etc.
- Demonstrate high level of flying skills.
- Be adept at normal and non-normal procedures.
- Maintain thorough systems knowledge.

Briefing and Communication

- Set an open tone.
- Fully brief operational / safety issues.
- Explicitly encourage participation.
- All are obligated to seek and give information.
- State how SOP deviations will be handled.
- Include cabin crew.

Leadership and Teamwork

- Balance authority and assertiveness.
- Promote continual dialogue.
- Adapt to the personalities of others.
- Use all available resources.
- Must share doubts with others.

Situational Awareness

- Monitor developments (fuel, weather, ATC, etc.).
- Anticipate required actions.
- Ask the right questions.
- Test assumptions, confirm understanding.
- Monitor workload distribution and fellow crewmembers.
- Report fatigue, stress, and overload in self and others.

Decision Making

- Fly the aircraft.
- Obtain all pertinent information.
- All crewmembers state recommendations.
- Better idea suggested? Abandon yours.
- Clearly state plan or intentions.
- Establish Bottom Lines.
- Resolve conflicts and doubts quickly.

Crew Self-Evaluation

- Debrief key events.
- Continuously provide information to self-correct.
- Openly discuss successes and mistakes.
- Ask, "How could we have done better?"
- Discuss what is right, not who is right.

CHECKLISTS**USE OF CHECKLISTS****Normal Checklists**

Checklist Initiation

There are three ways to initiate a checklist. The proper method is “Called For,” the backup method is “Prompted,” and the method of the last resort is “Self Initiated.”

“Called For” checklist initiation is the checklist habit pattern with the highest reliability. The Captain/PF initiates the checklist at the appropriate time. This manner ensures both crewmembers are aware that the checklist is in progress and specific actions are required.

“Prompted” checklist initiation is used as a backup “second line of defense” to ensure a checklist is accomplished. The pilot (who will accomplish the checklist) reminds the Captain/PF (who was supposed to call for the checklist) that the checklist needs to be accomplished. The Captain/PF, after being prompted, should then call for the checklist. Although it is not desirable, “Prompted” checklist initiation is an acceptable way to manage errors and recover total crew participation. A prompt (by the pilot who will accomplish the checklist) is required if a checklist has not been called for by the time a flight arrives at a certain point or time. This certain point or time is a bottom line for prompting a checklist. The following table lists the bottom lines for prompting all normal checklists.

PROPER "CALLED FOR" CHECKLIST INITIATION	ACCOMPLISHED BY:	BOTTOM LINE FOR PROMPTING
RECEIVING AIRCRAFT Called for by Capt when checks are done and there are no distractions.	F/O	When Agent asks "Are you ready?"
BEFORE START Called for by Capt when main cabin door is closed, all passengers are seated, carry-on luggage properly stowed, and aircraft movement is imminent.	F/O	Ready for pushback from ramp (or engine start if no pushback).
AFTER START Called for by Capt after the engine(s) have reached a stabilized idle and the headset operator has been cleared to disconnect.	F/O	Prior to brake release for taxi.
BEFORE TAKEOFF Called for by Capt when cleared on to the active runway.	F/O	Crossing the hold short line.
AFTER TAKEOFF Called for by PF after flaps up callout.	PM	10,000 feet MSL.
IN RANGE Called for by PF at approximately 18,000 feet MSL.	PM	10,000 feet MSL.
APPROACH Called for by PF in the approach environment.	PM	Cleared for the approach.

PROPER "CALLED FOR" CHECKLIST INITIATION	ACCOMPLISHED BY:	BOTTOM LINE FOR PROMPTING
LANDING Called for by PF in conjunction with the "Gear Down" call.	PM	1,000 feet AGL.
AFTER LANDING Called for by Capt after clear of all active runways.	F/O	Approaching ramp.
PARKING Called for by Capt after aircraft comes to a stop at the gate or parking spot.	F/O	Chocks in, parking brake off.
TERMINATION Called for by Capt after PARKING checklist is complete.	CAPT or F/O	Prior to leaving aircraft.

"Self Initiated" is the last chance method of ensuring a checklist is accomplished. The pilot performing the checklist initiates the checklist without participation of the other pilot. Self initiating any checklist is unprofessional and increases the chances for error due to lack of crewmember situational awareness. Self initiated checklist action has been contributory in many incidents and accidents. However, accomplishing the checklist under any condition is of such crucial importance that self initiating a checklist is appropriate when it is the only way to complete the checklist.

Checklist Accomplishment

The NORMAL checklist is used as a verification to ensure that certain critical or essential steps of the preceding procedure have been accomplished. The expanded checklists of this section serve the dual purpose of defining the procedure to be accomplished for each phase of flight and providing expanded notes appropriate to checklist accomplishment. Certain items in the expanded sections may be annotated "flow" after the challenge statement. These are items which are accomplished during the procedure, but are not rechecked during the reading of the checklist. The procedure defined for each phase of flight will be accomplished by recall (flow) prior to the reading of the applicable checklist. In all cases the checklist will be read from the electronic or printed checklist. At no time is the use of a checklist from memory acceptable.

If the flight deck is left unsupervised (all pilots away from the flight deck) prior to the BEFORE START checklist, all previously accomplished checklists must be re-accomplished in their entirety. If a non-crewmember is present on the flight deck during the absence of one or more crewmembers, the non-crewmember must be supervised by a remaining crewmember or any previously accomplished checklists must be re-accomplished.

The Captain will call for all checklists during ground operations. The Pilot Flying will call for all checklists in flight.

Normally a flow will be accomplished before the checklist is read. The point at which the associated flow may be initiated is defined in the preamble of each checklist. However, no flight control will be moved or positioned until called for.

Each item will be challenged out loud by the designated crewmember unless otherwise noted. The responding crewmember will visually confirm that the challenged action has been properly accomplished and will respond appropriately to the challenge, confirming the action or describing the configuration. Any item which has a numerical value or switch position associated with it, (i.e. reference speeds, altimeter settings, VNAV armed etc.) will have the associated value or switch position stated as a part of the response. Any item listing an "AS REQUIRED" response will be responded to by the actual configuration or condition as described in the expanded section. When responses are required by both crewmembers (F, C, or PM, PF), the pilot reading the checklist replies first followed by a crosscheck and identical reply from the other pilot. If a checklist item is not installed in a particular aircraft, the crewmember will nevertheless challenge the item and the response will be "NOT INSTALLED." Any action which has not been performed or completed when challenged must be completed before the next challenge is read. If performance of the challenged action cannot be completed immediately, the crewmember responding will reply "STANDBY" or other suitable response to indicate that further reading of the checklist will be suspended until the item can be accomplished.

Both pilots are responsible for visual confirmation that all checklist items are completed. Each checklist item will be treated separately, read in a command tone, and answered only when the challenged action has been completed and is in agreement with the appropriate response.

Checklist Completion

An unwritten last step of any checklist is for the pilot accomplishing the checklist to call the checklist complete. Calling the checklist complete is a last safeguard that everything is in order. When a checklist is complete, the announcement of “_____ CHECKLIST COMPLETE” mentally closes the loop on the process that began when the checklist was called for. This also mentally opens the door for the next activity. If the “_____ CHECKLIST COMPLETE” call has not been made, there is a strong possibility that things are not in order. The pilot performing the checklist should review it to verify all items have been accomplished and then make the “_____ CHECKLIST COMPLETE” call.

Non-Normal Checklists

“Fly the aircraft” is always an unwritten immediate action for any non-normal procedure. Both pilots will first give their attention to continued safe flight of the aircraft, with particular attention to flight path and communications.

Non-normal checklists assume crewmembers will:

- Silence aural warnings and reset Master Caution / Warning lights as soon as the cause of the warning is recognized.
- Test warning / status lights to verify valid indications.
- Check for tripped circuit breakers (refer to Circuit Breaker Procedures, Section 2, Non-Normals).

Caution: The intentional pulling and resetting of a circuit breaker is prohibited due to potential impact on multiple aircraft systems, except when specifically directed by a non-normal checklist or appropriate technical authority.

Procedures that prescribe an engine shutdown must be evaluated by the Captain to ascertain if an actual shutdown or operation of the engine at reduced thrust is the safest course of action. Consideration in this case must be given to probable effects if the engine is left running at minimum required thrust.

Checklist Initiation

When a non-normal situation occurs, the Pilot Flying (PF) will stabilize the aircraft and call out Immediate Action items. The Pilot Monitoring (PM) will accomplish the immediate action items and the PF will call for the appropriate checklist.

The Captain will then make the final determination as to who will be the PF and PM. In making this determination, the Captain should give consideration to his primary responsibility of managing the situation, in addition to the necessity of formulating a plan for successful resolution of the problem. By its very nature this includes a comprehensive coordination among ATC, the F/A, the company, and all other aspects of delegation of duties. The Pilot Monitoring (PM) will accomplish the appropriate checklist.

Checklist Accomplishment

Non-normal checklists are designed, with the exception of Immediate Action items, as “Read and Do” checklists. All items of any non-normal checklist will be read aloud. The pilot designated by the Captain to accomplish the checklist (PM) shall first read and respond to Immediate Action items (if applicable) to ensure that such items have been accomplished completely and correctly. The PM shall then complete the non-normal items by reading each item, accomplishing the required task, and reading the response. The PM, while accomplishing the checklist, will coordinate with the PF before changing any switch or control position which could potentially affect systems integrity or aircraft configuration.

Electronic checklist closed loop (sensed) checklist items turn from white to green when the action is taken. The PM is responsible to “check off” any open loop (not sensed) item and to ensure that all closed loop items are green.

Notes, information items, and condition statements are read aloud. The PF need not repeat these items, but should acknowledge that the items were heard and understood.

The PF is to be made aware when deferred items exist. Accomplishment of such items may be delayed until the appropriate point during approach or landing.

Consequential EICAS alert messages may be displayed as a result of a primary failure condition (such as AUTO SPEEDBRAKE from HYDRAULIC PRESS SYS C) or the result of non-normal checklist crew actions (such as PACK L from SMOKE AIR CONDITIONING). Consequential messages are displayed for crew awareness with icons automatically removed. Checklists corresponding to consequential messages may contain procedural steps, notes, or other information. The crew does not accomplish these checklists. If consequential checklist steps, notes, and information are applicable to the primary failure condition, then these are included in the primary checklist. Not all alert messages corresponding to the consequential checklist on the list may display while accomplishing the primary checklist. Display of consequential messages may vary depending on operational circumstance. The statement “Inhibited checklist:” followed by the list appears in the electronic checklist. The statement need not be read aloud when accomplishing electronic checklist. The statement “Do not accomplish the following checklist:” followed by a list of the checklists appears in the printed primary checklist to inform the crew of consequential checklists.

Following completion of appropriate non-normal checklist items, normal checklists are used as usual to verify that the configuration is correct for each phase of flight.

Pilots must be aware that checklists cannot be created for all conceivable situations and are not intended to replace good judgment. In some cases, deviation from checklists may, at the Captains’ discretion, be necessary.

There are some situations, which always require landing at the nearest suitable airport. These situations include, but are not limited to, conditions where:

- The non-normal checklist contains the words “Plan to land at the nearest suitable airport.”
- Cabin smoke or fire which persists. It should be stressed that for persistent smoke or a fire that cannot be positively confirmed to be completely extinguished, the earliest possible descent, landing, and passenger evacuation should be accomplished.
- One AC power source remaining (such as engine, APU, or backup generator), or
- Any other situation determined by the crew to present a significant adverse effect on safety if the flight is continued.

Checklist Completion

The checklist will be announced as “COMPLETE” when reaching the end of checklist symbol (* * * *). Care must be taken when a checklist is branched by the use of OR arrows as it may not be immediately apparent where the end of this branch of the checklist is located.

When a checklist is complete, the announcement of “_____ CHECKLIST COMPLETE” mentally closes the loop on the process that began when the checklist was called for. The pilot performing the checklist should review it to verify all items have been accomplished and then make the “_____ CHECKLIST COMPLETE” call.

When a non-normal checklist is complete except for the deferred items, and the normal checklist to which the items have been deferred has not yet been accomplished, the pilot monitoring states: “_____ CHECKLIST COMPLETE EXCEPT DEFERRED ITEMS.”

CHECKLIST FORMATTING

General

Checklists will be read from top-to-bottom, left-to-right. Careful attention must be paid to indentation so that only the appropriate items are performed. You may be required to “skip” downward over non-applicable steps or to move downward to a given location in the checklist. You will not be directed to go upward in the checklist (although you may have occasion to reenter a checklist if conditions change). You may be directed to cross reference another checklist.

If a checklist is “branched” (by an OR arrow), there will be more than one ending to that checklist. Checklists must be continued until the flight crew reaches an end-of-procedure symbol (four centered asterisks).

Challenge and Response

Checklist challenges are presented on the left with responses on the right in capital letters. A dotted line will separate challenges and responses.

ChallengeRESPONSE

A comma or ampersand (&) in a response indicates a combined response where more than one item must be verified to indicate compliance with the challenge.

Challenge RESPONSE A, RESPONSE B

A slash (/) between multiple responses indicates a choice of responses where only one of the choices is appropriate.

Challenge RESPONSE A / RESPONSE B

Under circumstances where both the Captain and First Officer or Pilot Monitoring and Pilot Flying are to respond to a given challenge, this will be indicated by (F, C) or (PM, PF) on the response side.

Oxygen CHECKED, SET, 100% (F, C)

Conditional (IF) Statements

In situations where particular steps within a procedure need to be performed only if a qualifying condition exists, these steps (which may be contained in a single-line “conditional” box to visually group the conditional items) will be preceded by an IF statement. This device indicates that the person reading the checklist must determine if the condition applies and if so, perform the items immediately below. If the condition does not apply, the steps immediately below, including all steps in a conditional box, should be skipped.

IF Condition A Applies:

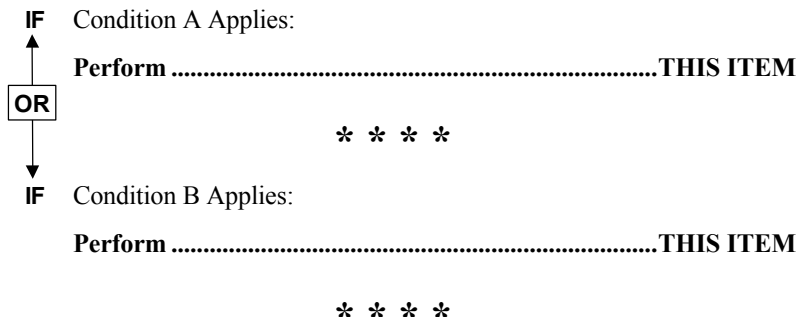
Perform.....THIS ITEM

IF Condition B Applies:

Perform.....THIS ITEM

OR Arrows

This device connects conditional items or groups of items which are mutually exclusive. This will indicate to the pilot that only one of the connected procedures should be performed and all others ignored. This device in effect “branches” the checklist and will result with more than one ending to the procedure.



Continue Checklist At ... Statements

If it is necessary to move from one point in a checklist, skip over one or more steps, and re-enter the checklist at another point further down the checklist, this device may be used. You would proceed from that point downward until encountering the appropriate numeric symbol which will be found on the left side of the margin.

IF Condition A Applies:

<p>Perform.....THIS ITEM</p> <p>Perform.....THIS ITEM</p> <p>IF Condition C Applies:</p> <p style="text-align: center;">↑</p> <div style="display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; padding: 2px 5px; margin-right: 5px;">OR</div> <div>Continue Checklist at ①</div> </div> <p style="text-align: center;">↓</p> <p>IF Condition D Applies:</p> <p style="padding-left: 40px;">Checklist is Complete.</p> <p style="text-align: center; margin-top: 20px;">* * * *</p>

IF Condition B Applies:

① Perform.....THIS ITEM

* * * *

The presence of the **①** next to the above step does not indicate that this step is only to be performed if Condition C applies. Note that this item would be accomplished whether Condition C or Condition B applies.

Phase Lines

A dashed line on either side of a condition statement in a procedure indicates that the crew may delay the performance of the procedure at that point. This is normally used to provide better “pacing” of a procedure. The crewmember reading the checklist is responsible for ensuring that the checklist is resumed at the appropriate time.

----- **BEFORE LANDING** -----

Cross Referencing

When a cross reference to another checklist is made it will be done in the following manner for normal and non-normal checklists:

Refer to AFTER TAKEOFF checklist, Section 3.

Refer to **ENGINE FAILURE** checklist, Section 2.

Continued Checklists

If a checklist or procedure is continued on the back of the page or on the next page, the word "Continued" will be printed centered in parenthesis at the bottom of the page.

(Continued)

Notes, Cautions, and Warnings

Notes, Cautions, and Warnings will be presented in the following format:

Note: Information requiring special emphasis.

Caution: Instruction concerning a hazard that if ignored could result in damage to an aircraft component or system.

WARNING: Instruction concerning a hazard that if ignored could result in loss of aircraft control, injury, or loss of life.

Action Specific Words

Certain words are used throughout this manual to indicate whether a procedure must be performed exactly as described at all times or if some discretion is allowed. These words are defined below for the purposes of Continental Airlines Flight Manuals. These definitions may differ slightly from certain dictionary definitions, however every attempt has been made to use these terms consistently as detailed.

The words "shall", "must", and "will" indicate procedures to be performed exactly as detailed. Deviations will be made only in situations equating to the use of pilot's emergency authority.

The word / phrase "should" and "strongly recommended" indicate procedures normally performed exactly as detailed. Deviation will be made only in unique situations where a pilot's best judgment indicates a different course of action. Such deviations would be very rare and briefed to all flight crewmembers.

The word “may” indicates procedures expected to be performed as detailed under most situations. While deviations are not limited to unique circumstances as above, use of these procedures are encouraged in the interest of standardization among flight crewmembers.

Crewmember Duties

Labels will be placed to indicate the crewmember to challenge the item and the crewmember assigned to respond or verify completion of the item. The following abbreviations will be used:


Captain	- Capt or C
First Officer	- F/O or F
International Relief Officer	- IRO
Pilot Flying	- PF
Pilot Monitoring	- PM

End-of-Procedure Asterisks

Four centered, bold asterisks indicate the end of a non-normal checklist.

*** * * ***

SECTION OVERVIEW & PROCEDURES**SECTION 1 - LIMITATIONS**

There are two separate categories for items contained in the limitations section. The first category, titled “Limitations”, includes limitations from the manufacturer’s FAA approved Airplane Flight Manual and additional items declared to be limitations by the Company. The Company limitations are designated by the symbol . All limitations must be memorized. The second category, titled “Operating Parameters”, contains items which should be complied with to ensure safe and efficient operation of aircraft systems. Flight crews are expected to have a working knowledge of the operating parameters.

SECTION 2 - NON-NORMALS

Non-normal procedures are presented in groups called “modules” composed of the expanded version checklist and in some cases a short narrative description and/or a profile or graphic description of the procedure.

The non-normal procedures in this manual represent the best available information. Flight crews should follow these procedures as long as they fit the situation. At any time they are not adequate or do not apply, the flight crew's best judgment should prevail.

The immediate action items will be memorized by each crewmember.

No throttle, fuel control switch, fire handle, or critical system control will be moved during any non-normal procedure without the concurrence of both crewmembers. All aural warnings should be silenced as soon as the emergency is recognized.

Time permitting, the Captain should utilize all available resources including, but not limited to, radio communications with Maintenance/ Engineering personnel.

Non-normal procedures are presented in expanded format grouped by aircraft system. It is not necessary to read the expanded verbiage aloud when performing the checklist unless clarification is desired. Checklist titles will reflect the EICAS indication or non-normal condition.

Cockpit Voice Recorder

Any incident requiring a report to NTSB, as defined in Section 1 of the Flight Operations Manual, and which results in termination of the flight, requires deactivation of the CVR upon termination of the flight to preserve the recorded information. This is accomplished by pulling the CVR circuit breaker located on the overhead circuit breaker panel. This will be noted in the Aircraft Maintenance Log.

Example: CVR deactivated because of reportable incident.

Note: The CVR circuit breaker is located on the overhead circuit breaker panel at position E-13, or in the E & E compartment. If in the E & E compartment, call Maintenance Control to pull this circuit breaker.

Enhanced Ground Proximity Warning System

The Enhanced Ground Proximity Warning System may be deactivated for approved non-normal procedures where use of flaps at less than normal landing flap positions are specified. A logbook entry is required.

SECTION 3 - NORMAL PROCEDURES

This section is intended as a training and reference section. Checklists are presented in normal flight order. Additional procedures and information are presented as necessary.

Operating procedures defined in this section are intended to conform with the objectives of the company which are to place safety, comfort, schedule reliability, and economy in their proper perspective. Conscientious adherence to these procedures is expected.

SECTION 3-1 - ETOPS / LRN

This section covers route planning and verification specific to ETOPS and Non-ETOPS Long-Range Navigation (LRN) operations. It is organized by phase of flight. An ETOPS/LRN Briefing Guide presented at the beginning of the section details specific crew responsibilities pertinent to ETOPS /LRN operations.

This section uses Atlantic Operations as the “standard” operating area and covers specific Pacific Operations as a separate subject.

MINIMUM EQUIPMENT LIST / CONFIGURATION DEVIATION LIST

The MEL provides for release of the aircraft for flight with inoperative equipment. When an item of equipment is discovered to be inoperative, it is reported by making an entry in the Aircraft Maintenance Record/Logbook. The item is then either repaired or may be deferred per the MEL or other approved means acceptable to the Administrator prior to further operation.

The MEL is located on the flight deck in a hardbound format. In the event the hardbound copy of the MEL / CDL is missing from the flight deck, contact Maintenance Control for dispatch information on inoperative equipment.

SECTION 5 - PERFORMANCE

This section is also organized by phase of flight. Most data are presented in tabular form and pilots may interpolate as necessary.

REQUEST FOR FEEDBACK

This Flight Manual is the result of the combined efforts of Flight Standards and Flight Operations. All flight crews are encouraged to comment on the contents of this manual, since its sole purpose is to provide you, the Flight Crew, with an accurate and effective tool to better help you do your job.

Suggestions, critiques, comments and corrections should be in writing and addressed to the Lead Line Check Airman in your crew base or to the respective Fleet Manager in Flight Standards. The boardmail address for each crew base is the three letter identifier of the base followed by the letters CP (i.e. IAHCP). The boardmail address for each fleet manager is IAHPS.

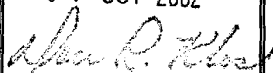
Your input is both desired and encouraged. All Flight Manuals are designed to be “living” documents, readily adaptable to new and better ideas, and easily revised.

LIST OF EFFECTIVE PAGES

PAGE	DATE	PAGE	DATE	PAGE	DATE
* TOC-1	11/01/02				
* TOC-2	11/01/02				
* 1	11/01/02				
* 2	11/01/02				
* 3	11/01/02				
* 4	11/01/02				
* 5	11/01/02				
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* 8	11/01/02				
* 9	11/01/02				
* 10	11/01/02				
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* 14	11/01/02				
* 15	11/01/02				
* 16	11/01/02				
* 17	11/01/02				
* 18	11/01/02				
* 19	11/01/02				
* 20	11/01/02				
* 21	11/01/02				
* 22	11/01/02				
* 23	Deleted				
* 24	Deleted				
* LEP-1	11/01/02				
* LEP-2	11/01/02				

FAA APPROVED

07 OCT 2002



DON R. KLOS
Principal Operations
Inspector

* Asterisk indicates page(s) revised or added by the current revision.

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LIMITATIONS AND OPERATING PARAMETERS**TABLE OF CONTENTS**

The information contained in this section meets or exceeds all requirements of the FAA approved Airplane Flight Manual (AFM). Both the AFM and Continental Airlines limitations are identified as “Limitations.” Limitations that are obvious, shown on displays or placards, or incorporated within an operating procedure are not contained in this chapter.

Flight crews are responsible for committing all information labeled “Limitations” to memory.

Additional “Operating Parameters” have been included in this section as a convenient reference. Flight crews are expected to have a working knowledge of these “operating parameters.”

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GENERAL LIMITATIONS

1. The B777 airplanes are certified in the transport category (FAR 25) and are eligible for the following types of operation when the required equipment is installed and approved in accordance with the applicable FARs.
 - Visual Flight (VFR)
 - Instrument Flight (IFR)
 - B777 Airplanes are category “C” for Instrument Approaches except for Circling, which is category “D.”
 - Night Flight
 - Icing Conditions
 - Extended Over Water Operations (ETOPS).
2. Minimum Flight Crew:
 - Captain and First Officer.

OPERATING LIMITATIONS / PARAMETERS

LIMITATIONS

1. Maximum Takeoff / Landing Pressure Altitude: 8,400 feet
2. Runway Slope: +/- 2%
3. Maximum Unrestricted Takeoff / Landing Tailwind Component: 10 Knots

Takeoffs and landings with tailwind components up to 15 knots are permitted with the following restrictions:

Takeoff:

- Specifically authorized by Pilot Weight Manifest
- Runway is clear and dry
- Antiskid and thrust reversers are fully operational
- Max takeoff rated thrust is used.

Landing:

- Aircraft performance landing weights are verified by reference to Section 5, Performance, LANDING FIELD LIMIT WEIGHT
 - Antiskid and thrust reversers are fully operational
 - Flaps 30 landing
 - Auto speed brakes are used
 - No braking action reports less than GOOD.
4. Flight Maneuvering Load Acceleration Limits

Flaps Up +2.5g to -1.0g

Flaps Down +2.0g to 0.0g

5. Flap Placard Speeds

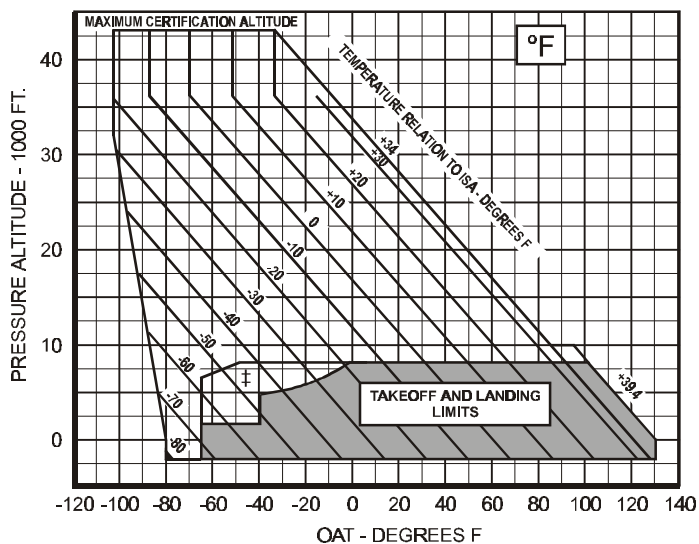
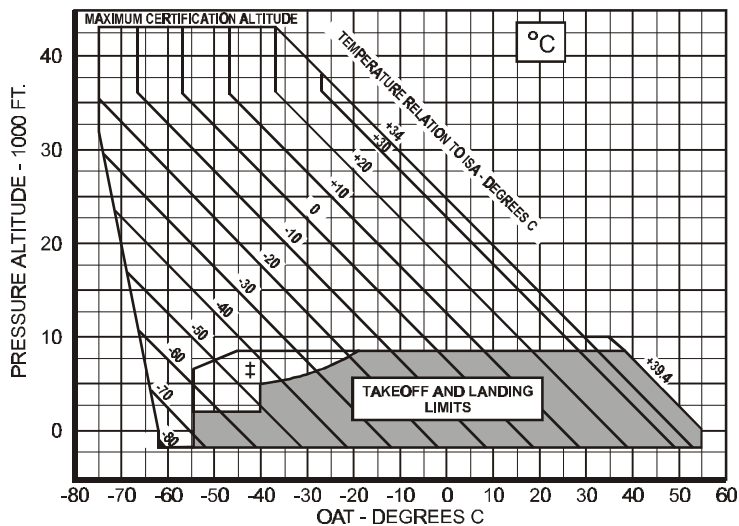
FLAP PLACARD SPEEDS	
FLAP POSITION	V _{FE} - KNOTS IAS
1	255
5	235
15	215
20	195
25	185
30	170

6. Maximum Landing Gear Operating Speeds (V_{LO}/M_{LO}) and Extended Speed (V_{LE}/M_{LE}) = 270 Knots IAS/0.82 Mach.

7. Environmental Envelope

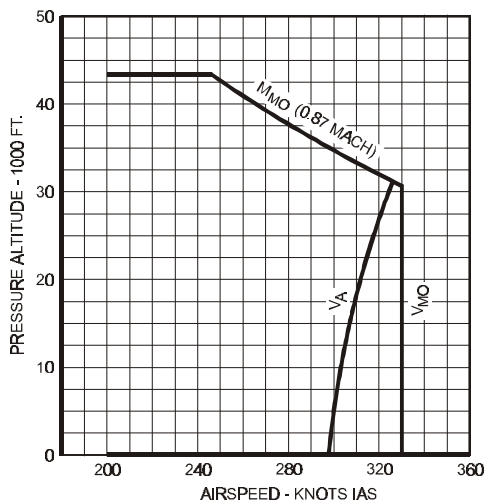
■ ISA +34°C FROM -2000 FT. TO 36,089 FT. ONLY.

‡TAKEOFF NOT PERMITTED IN THIS REGION; LANDING PERMITTED



8. The maximum operating limit speed shall not be deliberately exceeded in any regime of flight.

Note: All airspeed markings and placards in the airplane are shown as indicated (IAS) values, based on the primary static pressure source. The Air Data Inertial Reference System (ADIRS) corrects for static source position error and essentially displays knots CAS inflight. V_{MO} / M_{MO} , V_{LE} or flap placard speed (whichever is lower) is indicated by the lower edge of the red and black colored region of the speed tape on the Primary Flight Displays (PFD).



PARAMETERS

1. Maximum Operating Pressure Altitude: 43,100 feet
2. Turbulent Air Penetration Speed:
 - A. 270 KIAS below 25,000 feet
 - B. 280 KIAS/.82 Mach at and above 25,000 feet

3. Crosswind Landing Capability

Maximum Manufacturer's Demonstrated Takeoff / Landing Crosswind Component: 38 Knots

Accuload will generate a crosswind advisory when forecast crosswinds for takeoff or landing exceed 25 knots for wet runways or 15 knots for contaminated runways. This advisory will appear on line 9 of the accuload and in the T/O - LANDING PLAN SUMMARY of the pre-departure paperwork.

Aero studies were performed using a normal landing configuration, dry runway, with all engines operating, and engine out. The resulting crosswind guidelines are shown below.

Landing Crosswind Guideline – Knots

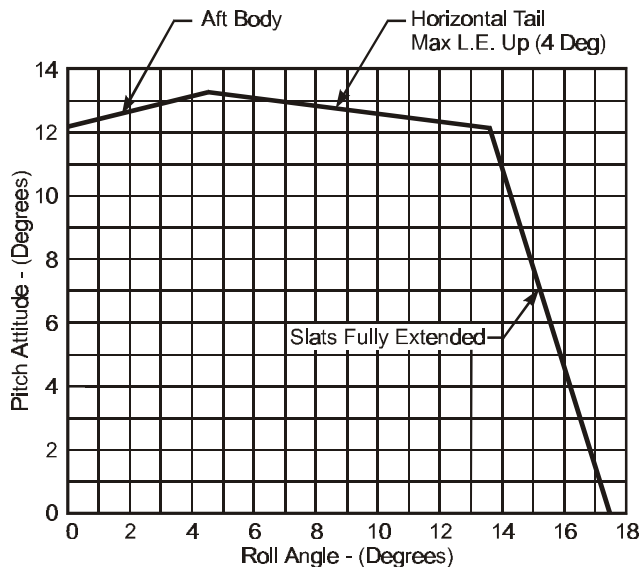
Runway Condition	Crosswind *
Dry	45 ***
Wet	40
Standing Water / Slush	20
Snow – No Melting	35
Ice – No Melting **	17

* Reduce crosswind guidelines by 5 knots on wet and contaminated runways whenever asymmetric reverse thrust is used.

** Landing on untreated ice or snow should only be attempted when no melting is present.

*** Sideslip only (zero crab) landings are not recommended in crosswinds in excess of 31 knots to maintain adequate control margin. This recommendation also ensures adequate ground clearance margins (see Ground Clearance Angle Chart).

The crosswind guidelines shown in the table above were derived through flight test data and analysis, and are based on steady wind (no gust) conditions.



777100s

**GROUND CLEARANCE ANGLES B777-200
(LANDING GEAR FULLY EXTENDED)**

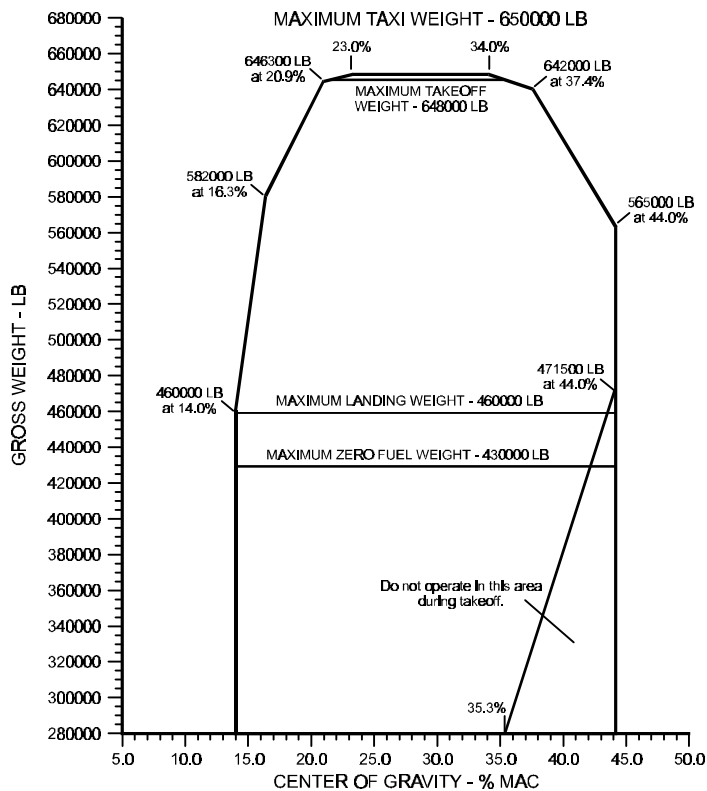
4. LAHSO:

Required Runway Length (Feet)	
Elevation < 2,000 ft.	Elevation ≥ 2,000 ft.
8,100	8,700

GROSS WEIGHT AND C.G. LIMITATIONS
--

WEIGHTS	POUNDS
Maximum Ramp	650,000
Maximum Takeoff	648,000
Maximum Landing	460,000
Maximum Zero Fuel	430,000

Refer to the applicable Weight and Balance Manual for specific loading and operating restrictions.



SYSTEM LIMITS AND OPERATING PARAMETERS**AIRPLANE GENERAL****Limitations**

1. Door Mounted Power Assists and Escape Slides:

Main door emergency power assists and evacuation slide systems must be armed with the mode select handle in the **ARMED** position prior to taxi, takeoff and landing whenever passengers are carried.

Operating Parameters

- A. Ground wind limits for all doors:

- 40 knots while opening or closing.
- 65 knots while open.

AIR SYSTEMS**Limitations**

1. Maximum Differential Pressure (relief valves): 9.1 psi
2. Maximum Differential Pressure For Takeoff/Landing: 0.11 psi

ANTI-ICE & RAIN**Limitations**

1. Engine Anti-Ice System:

Engine Anti-Ice must be AUTO or ON when the Total Air Temperature (TAT) is 10°C or less and icing conditions exist or are anticipated, except during climb, cruise and descent when the temperature is below -40°C SAT. Do not use anti-ice if OAT or TAT exceeds 10°C (50°F).

During ground operations in icing conditions (including taxi-in and taxi-out), each engine must be run up momentarily to a minimum of 50% N₁ at intervals not to exceed 15 minutes.

APU

Operating Parameters

1. No more than three (3) APU starts in a 60 minute period with the electric starter motor.

AUTOFLIGHT

Limitations

- 1. The autopilot must not be engaged below 1,000 feet radio altitude after takeoff.
- 2. Non Precision Approaches:
The autopilot must be disengaged before the airplane descends more than 50 feet below the MDA, unless it is in the go-around mode.
- 3. ILS Approaches:
Category III operations and autoland are not approved with flaps 25.
With **NO AUTOLAND** annunciated, the autopilot must be disengaged before the airplane descends below 200 feet AGL when coupled to the ILS glideslope and localizer.

AUTOMATIC LANDING

Limitations

1. Maximum allowable wind speeds for autoland operations:
Head Wind 25 knots
Tail Wind 15 knots
Crosswind 25 knots

Note: Maximum allowable crosswind is 15 knots for ILS approaches when the RVR is 2,400 feet or less. For Category II and Category III ILS approaches the maximum allowable headwind is 20 knots and the maximum allowable tailwind is 10 knots.
2. The maximum ILS glideslope angle is 3.25 degrees.
3. The minimum ILS glideslope angle is 2.5 degrees.

4. Automatic landings can be made using flaps 20 or 30 with either both engines operative or one engine inoperative. The autopilot flight director system (AFDS) autoland status annunciator must display either **LAND 2** or **LAND 3**.
5. Automatic landing cannot be made if the EICAS message **SLATS DRIVE** is displayed.
6. The B777 is not certified for autolandings at weights in excess of max landing weight.
7. The B777 is not certified for autolandings with the loss of two or more elevator hydraulic actuators. (Loss of R or C hydraulic systems results in loss of only one hydraulic actuator. Loss of the L hydraulic system or any combination of L, C, and R results in the loss of two or more hydraulic actuators.)

COMMUNICATIONS

Operating Parameters

1. Flight Deck Communications (Datalink):

The datalink from the COMPANY format is limited to the transmission and receipt of messages, which will not create an unsafe condition if the message is improperly received, such as the following conditions:

- The message or parts of the message are delayed or not received;
- The message is delivered to the wrong recipient; or
- The message content may be frequently corrupted.

The following procedures are applicable to the noted datalink functions from the COMPANY format:

- A. Pre-Departure Clearance:

The flight crew shall manually verify (compare) the filed flight plan versus the digital pre-departure clearance and shall initiate voice contact with Air Traffic Control if any question / confusion exists between the filed flight plan and the digital pre-departure clearance.

- B. Digital-Automatic Terminal Information Service:

The flight crew shall verify that the D-ATIS altimeter setting numeric value and alpha value are identical. If the D-ATIS altimeter setting numeric value and alpha value are different, the flight crew must not accept the D-ATIS altimeter setting.

C. Oceanic Clearances:

The flight crew shall manually verify (compare) the filed flight plan versus the digital oceanic clearance and initiate voice contact with Air Traffic Control if any questions / confusion exists between the filed flight plan and the digital oceanic clearance.

2. Satellite Communications System:

Satellite voice has been demonstrated for use only as a supplemental means of communications.

ENGINES

Limitations

1. Reverse Thrust:

- A. Backing the airplane with the use of reverse thrust is prohibited.
- B. Intentional selection of reverse thrust in flight is prohibited.

2. Per A.D. 2000-13-04 dispatch of the airplane with an engine-mounted backup generator having a sheared shaft is prohibited.

Note: It is CAL policy that if the **ELEC BACKUP GEN L, R** EICAS advisory message appears anytime prior to takeoff, and cannot be cleared after completing the associated non-normal checklist, the crew will contact maintenance and enter the event in the aircraft logbook. Maintenance must review MAT messages, check for servicing and leaks, and determine if the generator has a modified shaft installed. If all the parameters of the Backup Electrical Power System MEL item 24-25-1 are met the aircraft may depart with a sheared shaft. This procedure will normally necessitate a gate return and engine shutdown.

Operating Parameters

1. Engine Limit Display Markings:

- A. Maximum and minimum limits are RED
- B. Caution limits are AMBER.

2. Engine Oil

- A. Minimum quantity prior to engine start - 23 qts.
- B. Minimum quantity after engine stabilized and prior to flight - 18 qts.

FLIGHT CONTROLS

Limitations

1. Flight Controls:

Takeoff is permitted only in the normal flight control mode.



2. Speed Brakes:

Do not use the Speed Brakes in flight below 1,000 feet.

3. Flap Operation:

Do not extend flaps above 20,000 feet.

FLIGHT MANAGEMENT, NAVIGATION

Operating Parameters

1. Air Data Inertial Reference Unit (ADIRU):

Do not align ADIRU at North/South latitudes greater than 78 degrees, 14.75 minutes.

2. QFE Selection:

When using QFE instead of QNH a QFE altitude reference for the Primary Flight Displays (PFDs) must be selected in the Flight Management Computer (FMC).

The use of Vertical Navigation (VNAV) with QFE selected below the transition level is prohibited.

The use of Lateral Navigation (LNAV) with QFE selected below the transition level is allowed, provided:

- LNAV is disengaged during arrival prior to any altitude constrained conditional waypoint.
- LNAV is not engaged on departure until all altitude constrained conditional waypoints have been passed.

* A conditional waypoint defines an action at other than a geographically fixed position. An altitude constrained conditional waypoint defines an action (i.e., a turn), based upon passing an altitude.

3. VNAV level off:

Due to current software constraints within the FMC, VNAV may overshoot a level off altitude during climb or descent if:

- Leveling off within 2000 feet of the transition altitude or transition level.
- *and*
- The QNH setting is less than 29.70 hg / 1006 hPa (low altimeter setting).

Use **FLCH** for level off in these circumstances. After the level off is complete, **VNAV** may be re-engaged.

FUEL**Limitations**

1. The use of JP-4 and Jet B fuel is prohibited.
2. The maximum fuel temperature: 49°C.
3. Main tanks must be scheduled to be full if center tank fuel is loaded.

Note: The center tank may contain up to 3,000 pounds of fuel with less than full main tanks provided center tank fuel weight plus actual zero fuel weight does not exceed the maximum zero fuel weight, and the center of gravity remains within limits.

Operating Parameters

1. The minimum fuel temperature is 3° above the fuel freeze point (as shown on the following chart, or as determined from the Fuel Freeze Analysis if available).

FUEL FREEZE POINT

FUEL	FREEZE POINT – °C
JET A	-40
JP-5	-46
JET A-1	-47
JP-8	-50
TS-1 (TC1)	-50

OXYGEN**Operating Parameters**

1. The table below is used to determine proper flight crew oxygen bottle pressure for variations of ambient temperature:

This table is based on the Continental configuration of a two-bottle system (115 Cu. Ft. each).

BOTTLE TEMPERATURE		NUMBER OF CREW USING OXYGEN		
°C	°F	2	3	4
50	122	325	435	545
45	113	320	430	540
40	104	315	420	530
35	95	310	415	520
30	86	305	410	510
25	77	300	400	505
20	68	295	395	495
15	59	290	390	485
10	50	285	380	480
5	41	280	375	470
0	32	275	370	460
-5	23	270	360	455
-10	14	265	355	445

WARNING SYSTEMS**Limitations**

1. Enhanced Ground Proximity Warning System
 - A. Do not use the terrain display for navigation.
 - B. The use of terrain awareness alerting and terrain display functions are prohibited within 15 nm and approaching to land at an airport not contained in the EGPWS terrain database.

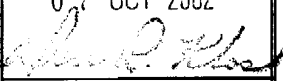
Note: All CAL Ops Spec Authorized Airports have been verified to be included in the EGPWS terrain database.

Operating Parameters

1. Pilots are authorized to deviate from their current ATC clearance to the extent necessary to comply with a TCAS II resolution advisory.

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LIST OF EFFECTIVE PAGES

PAGE	DATE	PAGE	DATE	PAGE	DATE
* TOC-1	11/01/02				
* TOC-2	11/01/02				
* 1	11/01/02				
* 2	11/01/02				
* 3	11/01/02				
* 4	11/01/02				
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* 15	11/01/02				
* 16	11/01/02				
* LEP-1	11/01/02				
* LEP-2	11/01/02				
<div style="border: 1px solid black; padding: 5px; text-align: center;"> FAA APPROVED 07 OCT 2002  DON R. KLOS Principal Operations Inspector </div>					

* Asterisk indicates page(s) revised or added by the current revision.

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2.0 - UNANNUNCIATED

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(u) BIO / CHEM HAZARD / THREAT

Condition: Suspected biological or chemical hazard / threat to the flight.

Contact SOCC: SOCC will coordinate with appropriate agencies to determine if the substance poses a credible threat.

IF SOCC determines that the substance does pose a credible threat:

Cover the material with the wipes and the plastic gown found in the onboard Universal Precaution Kit (UPK). If the UPK is not available, use a wet blanket to prevent airborne spreading of the material.

IF On The Ground:

Follow SOCC guidance.

OR

* * * *

IF Inflight:

Consideration should be given to landing as soon as practical based on analysis of the situation and coordination with SOCC.

If the material is airborne within the aircraft, the following procedures will minimize particulate flow into the flight deck and should be utilized.

Oxygen Masks And Smoke Goggles (If Required) ON

Crew Communications (If Required)..... ESTABLISH

Flight Deck Door..... CLOSE

Prevents material from penetrating onto the flight deck.

Recirculation Fans Switches..... OFF

Stops recirculation of material and increases fresh airflow.

Equipment Cooling Switch..... OFF

Attempts to move the material overboard by using the equipment cooling override mode.

Note: After 30 minutes of operation at low altitude and low cabin differential pressure, electronic equipment and displays may fail.

Do not accomplish the following checklist:

EQUIP COOLING OVRD

(Continued)

IF Most Of The Material Is In Cabin Forward Of Mid-Wing And
Outflow Valve Manual Control Available:

Aft Outflow Valve Switch.....MAN

Aft Outflow Valve Manual Switch.....CLOSE

Position outflow valve fully closed.

OR

Concentrates the material in the forward part of the aircraft and
attempts to remove it through the forward outflow valve.

Do not accomplish the following checklist:

OUTFLOW VALVE AFT

* * * *

IF Most Of The Material Is In Cabin Aft Of Mid-Wing And Outflow
Valve Manual Control Available:

Forward Outflow Valve Switch MAN

Forward Outflow Valve Manual SwitchCLOSE

Position outflow valve fully closed.

Concentrates the material in the aft part of the aircraft and
attempts to remove it through the aft outflow valve.

Do not accomplish the following checklist:

OUTFLOW VALVE FWD

* * * *

(u) CIRCUIT BREAKER

Condition: A circuit breaker (CB) has been found in the **out position**. This may be the result of:

- A **trip** due to an electrical fault,
- Inadvertent pulling, or
- Intentional pulling and failure to reset.

Caution: Due to potential impact on multiple aircraft systems the intentional pulling and resetting of a circuit breaker, other than when specifically directed by a non-normal checklist or appropriate technical authority, is prohibited.

IF fuel boost pump, fuel quantity indication system, or lavatory flush motor CB:

Do not reset.

OR

Enter the findings in the logbook and call maintenance.

* * * *

IF Preflight Before Block Out:

A CB found in the **out position** during preflight may be reset one time, unless:

- There is reason to believe that it has **tripped** due to an electrical fault, or
- The crew heard the CB pop or observed a change in the associated aircraft, system, or
- A logbook entry exists for the same CB being **tripped** in the previous 3 calendar days, or
- There is any associated electrical smoke/smell, or evidence of overheating of any aircraft system.

OR

If **any** of the above conditions are noted, do not reset the CB.

Enter the findings in the logbook and call maintenance.

* * * *

(Continued)



IF A CB Trips After Block Out and Before Takeoff:

Do not reset a **tripped** CB.

In the absence of electrical smoke/smell, or evidence of system overheating, the flight may continue provided the CB is not reset and MEL restrictions are met.

OR

A logbook entry is required.

* * * *

IF A CB Trips Between Takeoff And Block In:

One reset of a **tripped** CB may be attempted after a cooling period of approximately two minutes if:

- Called for during a non-normal checklist or procedure, or
- At the discretion of the Captain, **provided resetting the CB is necessary for the safe completion of the flight.**

Caution: If the CB trips again, **do not attempt another reset.**

A logbook entry is required.

* * * *

All **tripped** CBs, regardless of phase of flight and whether reset or not, must be written up in the aircraft logbook. This entry should include:

1. Time of occurrence (if known) in Z
2. Aircraft parameters when **trip** occurred (phase of flight, altitude / airspeed)
3. Weather conditions (if appropriate)
4. Name and location of the CB
5. Any pilot action that occurred prior to or during the **trip** sequence
6. Attempted reset and results
7. FRM fault code

(u) DATALINK RESET

Condition: DATA display not available on center VHF radio or ACARS
COMPANY pages not responding to an initialize request.

Display Select Panel COMM

On the MFD complete the following selections:

MANAGER SELECT

MASTER SELECT

DATALINK SYSTEM RESET SELECT

CONFIRM RESET SELECT

Display Select Panel AS DESIRED

* * * *

(u) DE-ICING PROCEDURE

Testing of undiluted deicing/anti-icing fluids has shown that some of the fluid remains on the wing during takeoff rotation and initial climb. The residual fluid causes a temporary decrease in lift and increase in drag and reduced thrust for takeoff is not permitted. Ensure that the recommended takeoff rotation rate is observed.

Caution: Snow/slush/ice ingestion in the APU inlet duct while the APU is running can cause serious damage. Operate the APU during de-icing procedures only if necessary.

Parking Brake Lever..... SET

This will preclude deicing fluid from penetrating the carbon disk brakes.

IF Using De-icing Fluid On The Aircraft Exterior With APU Or Engines Running:

Pack SwitchesOFF

To reduce pack wear, wait approximately 10 seconds for packs to completely shut down before positioning bleed switches to OFF.

ENG Bleed Switches (Engines Running).....OFF

Reduces the possibility of fumes entering the air-conditioning system.

APU Bleed Switch (APU Running).....OFF

Reduces the possibility of fumes entering the air-conditioning system.

Thrust Levers CLOSED

During de-icing, operate engines at idle to reduce the possibility of injury to personnel at inlet or exhaust areas.

Flaps UP

Prevents ice and slush from accumulating in the flap cavities.

Approximately 1 minute after completion of de-icing, restore engine and APU bleed air and pack operation.

Do not accomplish the following checklists:

BLEED LOSS BODY
BLEED LOSS WING L
BLEED LOSS WING R
PACK L
PACK R

* * * *

(u) DITCHING

- Send Distress Signal
- Advise Crew and Passengers
- Jettison Fuel As Required
- Accomplish IN RANGE CHECKLIST.

◀ ◀ ◀ ◀ ◀ DEFERRED ITEMS ▶ ▶ ▶ ▶ ▶

==> APPROACH CHECKLIST

----- WHEN BELOW 5000 FEET -----
 (OMIT LANDING CHECKLIST)

Ground Proximity Gear Override Switch.....OVRD

Ground Proximity Terrain Override SwitchOVRD

Pack SwitchesOFF

Ensures aircraft is depressurized for opening passenger entry doors.

Outflow Valve SwitchesMAN

Outflow Valve Manual Switches..... CLOSE

Position outflow valves fully closed.

Prevents water from entering aircraft through the valves.

Seat Belts SelectorON

APU Selector.....OFF

Closes the fuel valve and air inlet door.

Cockpit Loose Gear.....SECURE

Cockpit DoorSECURE OPEN

Life Vests.....ON

Don life vests, but do not inflate until after exit from aircraft.

Shoulder Harnesses and SeatbeltsON

Put on shoulder harnesses and seat belts and adjust for snug fit.

(Continued)

Passenger Cabin Preparation.....COMPLETE

Verify passenger cabin preparations for ditching are complete. All available food, fluids, flashlights, first aid kits, and other emergency equipment confirmed ready for evacuation. Seat passengers with life vests on and seat belts fastened.

RadioTRANSMIT FINAL POSITION

Transmit all information pertaining to: final ditching position, weather and sea conditions, rescue instructions if a ship or other rescue unit is standing by, and any other necessary information.

Emergency Lights.....ON

Insures lighting is available after electrical power is lost.

Landing Gear Lever..... UP**Flaps30**

Allows lowest V_{REF} speed for approach.

Extend flaps to 30 or appropriate landing flap for an existing emergency or non-normal conditions.

- Advise crew and passengers “BRACE FOR IMPACT” when within 30 seconds of touchdown.
- Maintain airspeed at bug and 200 – 300 fpm descent rate.
- Plan to touchdown on upwind side and parallel to waves or swells if possible.
- Advise cabin crew of imminent touchdown.
- Maintain airspeed at $V_{REF}30$ to touchdown. Flare aircraft to achieve minimum rate of descent at touchdown.
- To accomplish flare, rotate smoothly to touchdown attitude of 4 - 5°, maintaining airspeed and rate of descent with thrust. After touchdown, reduce thrust to idle.

Do not accomplish the following checklists:

CABIN ALTITUDE AUTO

PACK R

PACK L

(Continued)

----- ON THE WATER -----

Fuel Control Switches..... CUTOFF

APU Fire Switch..... OVERRIDE AND PULL

Removes electrical power which ensures passenger entry door flight locks are unlocked.

Passenger Evacuation "EASY VICTOR, EASY VICTOR"

After Landing Duties ACCOMPLISH

- | | |
|----------------|--|
| Captain: | Proceed to forward cabin area. Evaluate escape potential. Supervise and assist cabin crew in evacuation of aircraft. |
| First Officer: | Assist Captain and cabin crew in evacuation of aircraft. |
| IRO | Assist Captain and cabin crew in evacuation of aircraft. |

The aircraft may remain afloat indefinitely if fuel load is minimal and no serious damage was sustained during landing.

* * * *

DITCHING NOTES

Preparation

Condition: Aircraft ditching and evacuation are required.

Plan to jettison fuel as required. Reduces V_{REF} speeds.

Checklist use is based upon the recognition of conditions, which preclude continuation of the flight to a suitable landing, requiring aircraft ditching and evacuation.

- Send Distress Signal

On command, First Officer will transmit "MAYDAY" message, including position, course, speed, altitude, situation, intention, time and position of intended touchdown, type of aircraft, and request ASR intercept using prevailing air to ground frequency. He will set transponder code 7700 and, if practical, advise Captain of course to nearest ship or landfall.

- Advise Crew and Passengers

Alert crew and passengers to prepare for ditching. Order all loose equipment in aircraft secured. Put on life vest, shoulder harness, and seat belts. Do not inflate life vest until after exiting the aircraft.

- Jettison Fuel As Required

Consider jettisoning fuel prior to ditching if emergency permits. This will provide greater buoyancy and a lower V_{REF} . However, do not reduce the fuel to a critical amount, since ditching with thrust available improves the ability to properly control touchdown.

- Accomplish IN RANGE CHECKLIST.

Doors

The aircraft is equipped with 8 slide rafts. In a ditching situation, all cabin exits will normally be usable; however, situational awareness should always prevail. No exit that is below the water line should be used unless no other alternative is available.

Raft Capacity

The B777 is equipped with 8 slide rafts with the following capacities:

Exit Location	Normal Capacity	Overload Capacity
1L / 1R	65 / 65	81 / 81
2L / 2R	57 / 57	71 / 71
3L / 3R	51 / 51	63 / 63
4L / 4R	60 / 60	75 / 75
Totals	466	580

The overload capacity is calculated as the number of people inside the raft and maintaining 6" of raft above the waterline.

Survival Equipment

Each Slide / Raft has a survival kit tethered to it. After separating the raft from the aircraft, the survival kit should be retrieved immediately. Each kit is divided into two separate compartments. One compartment contains the canopy and supports while the other compartment contains all other survival equipment divided between two vacuum-sealed pouches.

The equipment side of the survival kit contains:

- Sky Blazer Flares
- Battery Flashlights
- Sea Dye Marker
- Signal Mirror
- Whistle
- Bailing Bucket
- First Aid Kit
- Drinking Water
- Raft Repair Kits
- Water Proof / Tear Resistant Survival Manual

The hand pump is attached to the raft adjacent to the inflation / deflation valves.

Erecting Canopy

- Remove canopy and support rods from the survival kit.
- Unfold canopy down the length of the raft.
- Attach canopy to the inflated canopy side supports on the raft (on some rafts, the aspirator valves will serve as supports).
- Assemble the center support rods (3 piece rods attach down the center of the raft, 2 piece rods attach at each end of the raft).
- Tie down the sides of the canopy to the raft.

Emergency Transmitters

The B777 has 2 emergency locator transmitters attached to the slide / rafts at doors 1L and 4R.

- Transmitter should activate automatically upon deployment of slide/raft.
- Check for red light flashing; if not flashing ensure lanyard is pulled.
- Touch the contact pads at the base of the antenna with a damp finger.
- Straighten the antenna if bent.

Flight Attendant Responsibilities

Land and Ditching

F/A	JUMPSEAT	EMER. & NORMAL DEMO	AREA OF RESPON.	BRIEFS ABAs	COMM. EVAC.
A	1L, Aft Facing	P.A.	A Zone	3 For Door 1L	1L
B	2R	A Zone, First Row, A/C Left	A Zone	3 For Door 2R	2R
C	2L	B Zone, First Row, A/C Left	Mid Galley & B Zone	3 For Door 2L	2L
D	3L, Aft Facing	D Zone, First Row, A/C Left	C Zone	3 For Door 3L	3L
E	4L, Fwd Facing	D Zone, Mid Cabin, A/C Left	Aft Galley & D Zone	3 For Door 4L	4L
F	3R, Aft Facing	C Zone, First Row, A/C Right	D Zone	3 For door 3R	3R
G	4R Fwd Facing	D Zone, First Row, A/C Right	D Zone	3 For Door 4R	4R
H	1R	A Zone, First Row, A/C Right	Fwd Galley And A Zone	3 For Door 1R	1R
I	3L, Fwd Facing	C Zone, First Row, A/C Left	C Zone	Assist As Needed	Cabin Director, C Zone
ABOVE FLIGHT ATTENDANTS ARE MINIMUM CREW					
J	3R, Fwd Facing	B Zone, First Row, A/C Right	C Zone	Assist As Needed	Assist As Needed
K	4R, Aft Facing Aisle	C Zone, Mid Cabin, A/C Right	Assist As Needed	Assist As Needed	Assist As Needed
L	1L, Fwd Facing	Assist As Needed	Assist As Needed	Assist As Needed	Assist As Needed
M	4L, Aft Facing, Aisle	Assist As Needed	Assist As Needed	Assist As Needed	Assist As Needed
N	4, Aft Facing, Center	Assist As Needed	Assist As Needed	Assist As Needed	Assist As Needed
O	45F	Assist As Needed	Assist As Needed	Assist As Needed	Assist As Needed

In a ditching situation:

- ☐ A Zone Rows 1 – 5
- ☐ B Zone Rows 8 – 10 (On some aircraft, B zone is rows 8 – 11)
- ☐ C Zone Rows 16 – 28 (On some aircraft, C zone is rows 16 – 27)
- ☐ D Zone Rows 32 – 45
- ☐ Flight Attendant A ensures the emergency lights are activated.
- ☐ Flight Attendants B and E retrieve spare life vests.

Flight Deck Ditching Responsibilities

	<u>CAPTAIN</u>	<u>FIRST OFFICER</u>	<u>IRO *</u>
B E F O R E L A N D I N G	<p>Advise cockpit & cabin crew to prepare for ditching.</p> <p>Don life vest (do not inflate)</p> <p>Determine position and set course for nearest land or surface vessel.</p> <p>Determine if fuel is to be dumped.</p> <p>Confirm cabin is depressurized prior to ditching.</p> <p>Advise cabin crew and passengers when within 30 seconds of impact (seat belt sign ON).</p> <p>Emergency light switch ON.</p> <p>Land with gear up and full flaps.</p> <p>Land with 4°-5° pitch up.</p>	<p>When advised to prepare for ditching:</p> <p>Don life vest do not inflate</p> <p>Send distress call (Mayday)</p> <p>Give position, status and intentions.</p> <p>Select transponder to 7700.</p> <p>Jettison fuel on command; when complete secure jettison system.</p> <p>Below 5,000':</p> <p>GPWS:</p> <p style="padding-left: 40px;">Gear override switch to override.</p> <p style="padding-left: 40px;">Terrain override switch to override.</p> <p>Depressurize on command:</p> <p style="padding-left: 40px;">Pack switches off</p> <p style="padding-left: 40px;">Outflow valve switches both manual</p> <p style="padding-left: 40px;">Outflow valve manual switches both closed</p> <p>APU switch off</p> <p>If no IRO:</p> <p style="padding-left: 40px;">Secure loose gear</p> <p style="padding-left: 40px;">Secure cockpit door open</p>	<p>When advised to prepare for ditching:</p> <p>Don life vest do not inflate</p> <p>Secure loose gear</p> <p>Secure cockpit door open</p>
W A N T E R	<p>Fuel control switches to cutoff</p> <p>Passenger evacuation</p> <p>"Easy Victor, Easy Victor"</p>	<p>Override and pull APU fire switch.</p> <p>Proceed to overwing area.</p> <p>Evaluate escape potential; supervise and assist cabin crew in evacuating aircraft.</p>	<p>Proceed to overwing area.</p> <p>Evaluate escape potential; supervise and assist cabin crew in evacuating aircraft.</p>
A B R A C K D O F T	<p>Verify survival gear, food, water is in raft.</p> <p>After all possible assistance is rendered, board and take command of any raft. Ensure separation from girt.</p>	<p>Verify survival gear, food, water is in raft.</p> <p>After all possible assistance is rendered, board and take command of any raft. Ensure separation from girt.</p>	<p>Verify survival gear, food, water is in raft.</p> <p>After all possible assistance is rendered, board and take command of any raft. Ensure separation from girt.</p>
	* Aircraft Qualified Observer assist / perform duties of the IRO. All other observers return to cabin and assist flight attendants with customer evacuation.		

(u) DUAL ENG FAIL/STALL

Condition: Engine speed for both engines is below idle.

This procedure is to be used if throttle response is lost from both engines. The procedure can be used at any speed or altitude in the aircraft's operating envelope. The probability of a hot start is increased above 30,000 feet. The probability of a successful start is improved at altitudes below 30,000 feet.

For descent information see the Two-Engine Inoperative Driftdown Chart in Section 5.

During descent, this condition may first be indicated by **ELEC AC BUS L, R** or **ENG OIL PRESS L, R** EICAS messages. If these messages appear during descent, check N_2 and EGT to verify engine operation.

IMMEDIATE ACTION**Fuel Control Switches.....CUTOFF, THEN RUN**

Attempts to clear stall condition and allow engines to be put into start mode.

Ram Air Turbine Switch PUSH

Push and hold for 1 second.

Backs up automatic deployment of RAT.

The immediate action item should be accomplished expeditiously to effect an immediate restart before the engines have spooled down completely.

This emergency is most likely the result of flight into areas of heavy/extreme precipitation, severe turbulence or volcanic ash. In such conditions, it may take up to two and a half minutes to accelerate to idle thrust. Successful start(s) may not be possible until after leaving the precipitation. Repeated attempts at restarting the engine(s) may be necessary once clear of heavy rain, sleet, or hail.

An auto-relight is provided for flameout protection. Whenever the EEC detects an engine flameout, both igniters are activated. A flameout is detected when a rapid decrease in N_2 occurs, or N_2 is less than idle RPM. For in-flight starts, autostart makes continuous attempts until the engine either starts or the pilot aborts the start attempt by positioning the FUEL CONTROL switch to CUTOFF (and positioning the start switch to NORM if it was a starter assisted attempt.)

(Continued)

SECONDARY ACTION

AirspeedABOVE 270 KTS

Ensures best windmill start capability. Engines may accelerate to idle slowly. The time from fuel control switch to RUN to stabilized idle may be as long as two and a half minutes. If N_2 is steadily increasing, and EGT remains within limits, the start is progressing normally.

Be aware of possible asymmetrical thrust conditions depending upon individual engine start and acceleration times.

APU Selector (If APU Available)..... START, RELEASE TO ON

Backs up automatic APU start

When **HEAT PITOT L+C+R** message no longer displayed:

Primary Flight Computers**Disconnect Switch DISC, THEN AUTO**

Restores flight control normal mode following reversion to secondary mode caused by loss of pitot heat.

Autopilot can be re-engaged when flight control normal mode is restored.

* * * *

(u) EMER EVAC PLANNED

The possibility of a passenger evacuation may be anticipated or unanticipated. However, it is impossible to include all of the variables. Any time the situation demands a deviation from the established procedure, crew members should exercise their best judgment and act accordingly.

Primary evacuation route for the cockpit crew is through the passenger cabin, assisting as necessary, and exiting down on of the evacuation slides.

Secondary evacuation route is through the cockpit windows. It is not intended that crew members assume unnecessary risks. When all efforts to aid passengers have been expended, the crew should act in the best interest of personal safety. When an emergency occurs inflight which could result in an evacuation, the passenger evacuation planned checklist will be used.

- Advise flight attendants of emergency.
 - T – Type of emergency expected.
 - E – Evacuation, will it be necessary?
 - S – Signal for brace and evacuation.
 - T – Time available for preparation.
- Notify ATC and the Company.
- Unlock cockpit door and lock open
- Jettison fuel (if advisable).

----- WHEN BELOW 10,000 FEET -----

- Depressurize aircraft before landing, Turn L+R pack off.
- OUTFLOW VALVE switches both MAN.
- OUTFLOW MAN switches both OPEN.
- It is recommended that all available gear be extended.
- 30 seconds prior to touchdown, make a PA: “BRACE FOR IMPACT”
- Turn on emergency lights.

Do not accomplish the following checklists:

PACK L
PACK R
CABIN ALTITUDE AUTO

(Continued)

----- AFTER AIRCRAFT COMES TO STOP -----

Parking Brake	SET (C)
Tower/Ground.....	CONTACT (C)
Outflow Valve Switches.....	MAN (F)
Outflow Valve Manual Switches.....	OPEN (F)
 IF Evacuation Is Required:	
Fuel Control Switches.....	CUTOFF (C)
Passenger Evacuation	EASY VICTOR, EASY VICTOR (C)
Engine Fire Switches.....	PULL AND ROTATE (F)
APU Fire Switch.....	OVERRIDE, PULL AND ROTATE (F)

(CAPTAIN DUTIES)

Parking BrakeSET (C)

Ensure Parking Brake Set to prevent aircraft movement while evaluating the requirement for evacuation.

Tower / Ground..... CONTACT (C)

Contact any available resources outside the aircraft for information, which will assist in the evacuation decision. Notify of abnormal aircraft conditions and the decision to evacuate or not.

(FIRST OFFICER DUTIES)

Note: PA: "REMAIN SEATED, REMAIN SEATED. As the aircraft comes to a stop make a PA to allow time to configure the aircraft for evacuation.

(Continued)

Outflow Valve SwitchesMAN (F)

Select the FWD and AFT outflow valve switches to manual to facilitate depressurizing the aircraft in preparation for evacuation should the Captain confirm the need to evacuate.

Outflow Valve Manual Switches OPEN (F)

Manually open both outflow valves to ensure aircraft is depressurized for opening passenger entry doors if the Captain confirms the need to evacuate.

IF Evacuation Is Required:

(CAPTAIN DUTIES)

Fuel Control SwitchesCUTOFF (C)

Shuts down engines, unlocks engine fire switches, and ensures passenger entry door flight locks are unlocked. For the safety of personnel evacuating, ensure positive shutdown of both engines when the decision is made to evacuate the aircraft.

Passenger Evacuation “EASY VICTOR, EASY VICTOR” (C)

Command the crew to begin evacuation by stating “EASY VICTOR, EASY VICTOR” using the P.A. system. Do not specify an exit or exits to be used. Flight Attendants are trained to evaluate escape potential at each exit and use or block exits based on observed conditions. Notify the Tower.

OR

(FIRST OFFICER DUTIES)

Engine Fire SwitchesPULL AND ROTATE (F)

Engines: Rotate switches in opposite directions. Rotate to the stop and hold for 1 second. Shuts off combustibles and discharges fire extinguisher bottles to reduce potential risk of fire.

APU Fire Switch OVERRIDE, PULL AND ROTATE (F)

APU: Override and rotate switch to the stop and hold for 1 second. Shuts down APU, discharges fire extinguisher bottle to reduce potential risk of fire, and removes electrical power which ensures passenger entry door flight locks are unlocked.

(Continued)

(CREW EVACUATION DUTIES)

- Captain: Direct and assist passenger evacuation. Ensure all passengers and crew have evacuated the aircraft.
- F/O: Assist Flight Attendants as necessary to ensure appropriate door(s) open and escape slide activated. Proceed to ground without delay. Evaluate escape routes, coordinate, and assist with evacuation. Direct passengers to assembly point.
- IRO/ACM: If qualified, assist Flight Attendants in passenger evacuation.

Preferred Routes Of Escape - Land**Belly Landing (All Gear Retracted)**

Evacuation Routes:

- All slides are very shallow.

Nose Gear Collapse (Nose Low / Tail High)

Evacuation Routes:

- Forward slides are very shallow.
- Aft slides are very steep, but usable.

Main Gear Collapse (Nose High / Tail Low)

Evacuation Routes:

- Forward slides are slightly steeper than normal.
- Aft slides are shallow.

One Main Gear Collapse (One Side High / One Side Low)

Evacuation Routes:

- All slides usable. Caution should be used at exits on the high side due to possible steep angle of slides.
- Potential fire hazard on low side.

(Continued)

IF Evacuation Is Not Required:

Identify the malfunction and accomplish the appropriate checklist, as required.

- - - - AFTER PROBLEM IS STABILIZED - - - -

Do not taxi until the flight attendants verify all passengers are seated and all doors / exits are closed.

A brief PA reassuring that the situation is under control and advising of your intentions will assist the cabin crew in controlling the cabin and relieving passenger concerns.

After Landing Checklist ACCOMPLISH

Caution: If tire damage is suspected, do not retract flaps.

* * * *

EMER EVAC PROCEDURE

The Emergency Evacuation Checklist should be used in any situation where the Captain feels the potential for evacuation exists. Initiating the checklist does not indicate that an evacuation will occur, it merely sets in motion a procedure, which will prepare the aircraft for orderly evacuation of all passengers and crew immediately after the ultimate decision to evacuate, is made by the Captain. The Captain's primary responsibility is to decide if the passenger evacuation is necessary. The F/O's primary responsibility is to configure the aircraft so that if the Captain decides to evacuate, the aircraft is immediately ready.

The checklist and aircraft evacuation placard indicates a two-step procedure. The upper portion of the checklist (those steps above the statement "If Evacuation is Required") defines the preparation and decision making steps. Duties normally performed by the Captain are listed first, followed by F/O duties. A blank line separates the steps. These steps should be performed essentially simultaneously and by reference to the placard and flow if applicable. The lower portion of the checklist defines the steps to be performed if the Captain has made a decision to evacuate the aircraft. The steps normally performed by the Captain are listed first and the F/O steps printed following a blank line.

Once the aircraft is at a complete stop, the Captain will set the parking brake and call for the Emergency Evacuation Checklist. The Captain should then communicate with whomever he feels may be able to offer information, which will aid in the evacuation decision, i.e., ATC, ground vehicles, and cabin crew. The F/O should take the initiative to prompt the Captain if he/she neglects to call for the Emergency Evacuation Checklist. These steps are "transparent" to passengers and cabin crew and should not create a potential for an uncommanded evacuation.

While the Captain is making the evacuation decision, the F/O will quickly perform or verify the steps of the checklist down to the statement "If Evacuation is Required," by flow and/or reference to the evacuation placard. If the placard was not used initially, the checklist should be performed by Challenge / Response / Response down to the decision point. At this time the checklist should be paused and the F/O should direct his/her attention to the Captain to be ready to proceed with the course of action decided by the Captain. If the Captain decides an evacuation is required, he/she will position the start levers to cutoff and order the evacuation by using the PA. When the F/O notes the Captain's decision by verbal confirmation from the Captain or by observing the evacuation command, he/she will continue the final steps of the checklist by Challenge / Response / Response.

If the Captain decides not to evacuate the aircraft the F/O will await further direction by the Captain. A “REMAIN SEATED” command and PA announcement to inform and calm the passengers should be given by the Captain or his designee.

(u) ENG ABORTED START L, R

Condition: Start parameters exceeded or EGT rising rapidly approaching limit during an engine manual start.

Fuel Control Switch CUTOFF

Removes fuel and ignition from the engine.

IF On The Ground:

Start/Ignition Selector..... START

Motor engine for 30 seconds.

Expels unused fuel from the engine.

Start/Ignition Selector..... NORM

* * * *

(u) ENG BATTERY START

Accomplish the normal EXTERIOR INSPECTION and the normal PREFLIGHT PROCEDURE - First Officer, through “Circuit Breakers Check.”

Battery SwitchON

**C1 and C2 Primary Pump Switches and
All Demand Pump SelectorsOFF**

Wiper SelectorsOFF

Landing Gear Lever.....DN

Alternate Flaps SelectorOFF

**Standby Power Switch (Overhead
Maintenance Panel) PUSH TO BAT,
RELEASE TO AUTO**

Center Bleed Isolation SwitchOFF

Ground Pneumatic Source (If Available).....CONNECT

IF The APU Is Required For Pneumatic Power:

APU Selector..... START, RELEASE TO ON

Speedbrake Lever.....DOWN

Reverse Thrust LeversDOWN

Thrust Levers CLOSED

Flap Position Indication And Flap Lever.....AGREE

Parking Brake Lever..... SET

Fuel Control Switches CUTOFF

Captain’s Audio Control Panel..... SET

Start the left engine using the normal Engine Start procedure. Bleed air is available only to the left engine.

Limit start attempts to one autostart or two manual start attempts.

(Continued)

- - - - - AFTER LEFT ENGINE IS STARTED - - - - -**Ground Pneumatic Source (If Used)..... DISCONNECT****Center Bleed Isolation Switch AUTO**

Complete the normal Preflight, Before Start, and Engine Start procedures.

*** * * ***

(u) ENG CROSSBLEED START

The APU must be shutdown or the APU Bleed switch must be turned OFF.

Verify the area behind the aircraft is clear of equipment and personnel prior to increasing thrust on operating engine.

Thrust Lever (Operating Engine).....ADVANCE

 Increase thrust until 5% N₂ above idle (25 PSI minimum duct pressure).

 Accomplish normal engine start.

* * * *

(u) ENG INFLIGHT START L, R

Condition: Engine start is desired after a shutdown with no fire or apparent damage.

If not previously accomplished, complete the **ENG FAIL L, R** or **FIRE ENG L, R CHECKLIST** before attempting a restart.

Evaluate engine indications for evidence of damage, which would preclude a restart attempt.

Check the INFLIGHT START ENVELOPE to determine if a windmilling start or starter assist is required.

Starts may be attempted but are not assured outside EICAS envelope.

Monitor EGT during start. Prevents EGT exceedance because autostart allows EGT to exceed the inflight start limit.

IF X-BLD Displayed:



OR



Start/Ignition Selector START

Allows air to starter for a crossbleed start.

Fuel Control Switch RUN

For autostart OFF, position to RUN at maximum motoring.

IF X-BLD Not Displayed:

Fuel Control Switch RUN

Engine may accelerate to idle slowly. The time from fuel control switch to RUN to stabilized idle may be as long as two and a half minutes. If N₂ is steadily increasing, and EGT remains within limits, the start is progressing normally.

IF Engine Starts And Operates Normally:

Ground Proximity Flap Override Switch OFF

Transponder Mode Selector TA/RA

Autothrottle Arm Switch..... ARM

* * * *

(u) ENG LIM/SURGE/STALL L, R

Condition: Engine indications are abnormal or are approaching or exceeding limits, abnormal engine noises are heard, or there is no response to thrust lever movement.

Autothrottle Arm Switch..... OFF

Allows thrust lever to remain where manually positioned.

Thrust Lever RETARD

Retard until indications remain within appropriate limits or the thrust lever is closed.

Stabilizes airflow through engine.

IF Indications Abnormal Or EGT Continues To Increase:



Fuel Control Switch..... CUTOFF

APU Selector (If APU Available) START, RELEASE TO ON

Provides an additional source of electrical power.

OR



Transponder Mode Selector..... TA ONLY

Prevents climb commands which can exceed single engine performance capability.

Plan to land at the nearest suitable airport.

IF Indications Stabilized/EGT Decreasing:

Thrust Lever.....ADVANCE

Advance slowly. Check that RPM and EGT follow thrust lever movement.

Attempts to restore normal control of engine operation.

Operate engine normally or at a reduced thrust level, which is surge and stall free.

Ground Proximity Flap Override Switch OVRD

Note: Use Flaps 20 and V_{REF} 20 for landing and Flaps 5 for go-around.

* * * *

(u) ENG MANUAL START**Autostart Switch.....OFF****Start / Ignition Selector..... START**

Oil pressure should rise before selecting RUN.

Place Fuel Control Switch to run when engine reaches max motoring,
minimum N₂ 22%.**Fuel Control SwitchRUN**

EGT should rise within 20 seconds after selecting RUN.

N₁ rotation must be indicated by 50% N₂.

Monitor engine parameters for exceedance.

N₂ should reach idle within two minutes after selecting RUN.**Autostart Switch.....ON**

When both engines are stabilized at idle.

If both engines are to be started manually, the AUTOSTART switch may remain
OFF between manual starts.

Captain	First Officer
Announce start sequence.	Position AUTOSTART switch to OFF.
Call "START ____ ENGINE."	Position ____ START/IGNITION selector to START.
Observe oil pressure increase.	
Position ____ FUEL CONTROL switch to RUN at max motoring N ₂ .	
Observe initial EGT rise and EGT within limits.	
	When engine is stabilized at idle, push AUTOSTART switch ON.

* * * *

(u) ENG START VALVE MANUAL

Start the engine using normal engine start procedure, except direct the ground crew to:

- Manually open the start valve after positioning START/IGNITION selector to START
- Manually close the start valve at 62% N₂.

Repeat procedure to start remaining engine.

* * * *

(u) ENG START WITH EXT AIR

Condition: APU air insufficient or unavailable.

Coordinate with ground crew placement of pneumatic air cart(s) on left side of aircraft.

Start right engine.

If a battery start is required (battery powers left start valve only) or left engine must be started first for operational reasons, the pneumatic air cart(s) may be positioned on the right side of the aircraft and the left engine started first.

Verify with ground crew that pneumatic air cart(s) clear of aircraft.

IF Crossbleed Start Required:

The APU must be shutdown or the APU bleed switch must be turned off.

Verify the area behind the aircraft is clear of equipment and personnel prior to increasing thrust on operating engine.

Thrust Lever (Operating Engine).....ADVANCE

Increase thrust until 5% N₂ above idle (25 PSI minimum duct pressure).

Accomplish normal engine start.

* * * *

(u) ENG SVR DAMAGE/SEP L, R

Condition: Engine has severe damage, vibration, or has separated.

This procedure is to be used for engine separation, shutdown due to severe damage, or shutdown for precautionary reasons.

Autothrottle Arm Switch **OFF**

Allows thrust lever to remain where manually positioned.

Thrust Lever **CLOSE**

Assists in recognition of affected engine.

Fuel Control Switch **CUTOFF**

Engine Fire Switch **PULL**

Shuts off fuel and hydraulic fluid.

IF High Airframe Vibration Occurs And Continues After Engine Shutdown:

Without delay, reduce airspeed and descend to a safe altitude which results in an acceptable vibration level.

If high vibration returns and further airspeed reduction and descent is not practical, increasing the airspeed may reduce the vibration.

APU Selector (If APU Available) **START, RELEASE TO ON**

Provides an additional source of electrical power.

Transponder Mode Selector **TA ONLY**

Prevents climb commands which can exceed single engine performance capability.

Plan to land at the nearest suitable airport.

Ground Proximity Flap Override Switch **OVRD**

Note: Use Flaps 20 and V_{REF} 20 for landing and Flaps 5 for go-around.

(Continued)

Logbook entries, if time and conditions permit.

- Windmill RPM
- Windmill time
- Windmill oil pressure
- Length of time engine windmilled without oil pressure
- Oil pressure at time of shutdown

Coordinate any procedure requiring an engine shutdown with ATC as soon as possible. If the shutdown occurs at an altitude above the single engine ceiling, initiate driftdown procedures. FMC information is available on the engine-out climb or cruise pages as applicable. Use these pages for driftdown speeds and power settings.

* * * *

(u) FIRE ENG TAILPIPE L, R

Condition: An engine tailpipe fire is reported with no engine fire warning.

Fuel Control Switch CUT OFF

Removes fuel and ignition from the engine.

IF Bleed Air Available:

Start / Ignition Selector..... START

Motor engine until tailpipe fire is reported extinguished.

Start / Ignition Selector..... NORM

Tower And Flight Attendants NOTIFY

* * * *

(u) FLIGHT DECK DOOR EMRG ENTRY ACTIVE

Condition: The FLIGHT DECK DOOR EMERGENCY ENTRANCE system has been activated for emergency flight deck access, or there is a *significant security incident* in the cabin.

IMMEDIATE ACTION

Flight Deck Door HARD LOCK Switch.....PUSH

This locks the door for 30 minutes. The 30-minute timer may be reset at any point by pushing the HARD LOCK switch again. Immediately contact the cabin and use the door viewing port to determine the nature of the incident. If communications with the cabin are not possible and the flight crew is unable to determine the severity of the incident, it will be considered a **LEVEL 4 SECURITY INCIDENT**.

If the HARD LOCK mode is not engaged, it presumes that all pilots are incapacitated, and after 30-seconds the alert warning will stop and the door will be unlocked for only 5 seconds to allow opening. If the door is not opened during this time, it will relock and the process will have to be repeated.

* * * *

(u) FLIGHT DECK DOOR UNLKD

Condition: There is a fault in the door control system, status lights, or lock mechanism and the security of the door is unknown.

Flight Deck Door Mechanical Lock PinENGAGE

Use of the mechanical lock pin prevents door from being opened by the FLIGHT DECK DOOR EMERGENCY ENTRANCE system. A flight attendant, working crew member, or other authorized ACM / jumpseat rider must remain on the flight deck to engage / disengage the mechanical lock pin anytime there is only one pilot on the flight deck. This is to insure access to the flight deck in the event the one pilot becomes incapacitated.

HARD LOCK Switch..... PUSH

If the UNLKD light is illuminated (*indicating a system fault*), pushing the HARD LOCK switch:

Will:

- extinguish the UNLKD light

Will not:

- engage HARD LOCK mode
- illuminate HARD LOCK light
- ensure the door is locked

* * * *

(u) FMC POSITION UPDATE

When the FMC message **VERIFY POSITION** is displayed, the FMC position may require updating.

Pos Ref (Page 2/3).....SELECT

POS REF 2/3 is the second page of POS INIT 1/3.

Compare the FMS positions with the displayed GPS, Radio, and Inertial positions.

Select the most appropriate source for FMC position updating.

Update Arm KeySELECT

The **ARM** prompt changes to **ARMED** and **NOW** prompts appear to the right of the remaining position sources.

Appropriate Source Update Now Key.....PUSH

* * * *

(u) FUEL JETTISON

Condition: Fuel jettison is required.

Note: If the **status** message **ELMS P110 PANEL** or **ELMS P210 PANEL** is displayed, indicating loss of both channels within the respective ELMS module, automatic shutoff function of the fuel jettison system is inoperative. Fuel jettison will have to be terminated by manually turning off the fuel jettison nozzle valves at the appropriate time. Additionally, the fuel synoptic indications, flow bars, and time to jettison information will be unreliable.

Fuel Jettison Arm SwitchARMED

IF Desired FUEL TO REMAIN Different Than Displayed FUEL TO REMAIN:

Fuel To Remain Selector PULL, SET MANUALLY

Fuel Jettison Nozzle Switches..... ON

Record the time jettison began, Lat/Long, and wind.

----- WHEN FUEL JETTISON COMPLETE -----

Fuel Jettison Nozzle Switches..... OFF

Fuel Jettison Arm Switch OFF

Record the Lat/Long and the amount of fuel jettison.

Following the fuel jettison expect a 1 minute delay before the fuel quantity reading is accurate.

* * * *

(u) FUEL LEAK

Condition: An in-flight fuel leak is suspected or confirmed.

One or more of the following may be evidence of a fuel leak:

- Visual observation of fuel spray from strut/engine
- Excessive engine fuel flow
- Total fuel quantity decreasing at an abnormal rate
- **FUEL IMBALANCE** EICAS message
- **FUEL QTY LOW** EICAS message
- **FUEL DISAGREE** message on the CDU scratchpad. (Displayed when difference between totalizer and calculated fuel values exceed 9000 lbs. for 5 min.)
- **INSUFFICIENT FUEL** message on the CDU scratchpad.

Center Fuel Pump Switches.....OFF

Crossfeed Switches.....OFF

Identify fuel leak at an engine by observing one main fuel tank quantity decreasing faster than the other. An increase in fuel imbalance of approximately 1000 lbs. or more in 30 minutes should be considered a fuel leak. Conditions permitting visually check for engine fuel leak.

IF Engine Fuel Leak Confirmed:

Autothrottle Arm Switch (Affected Engine).....OFF

Allows thrust lever to remain where manually positioned.

Thrust Lever (Affected Engine)..... CLOSE

Assists in recognition of affected engine.

Fuel Control Switch (Affected Engine) CUTOFF

APU Selector (If APU Available)..... START, RELEASE TO ON

Provides an additional source of electrical power.

Transponder Mode Selector.....TA ONLY

Prevents climb commands which can exceed single engine performance capability.

(Continued)

IF FUEL DISAGREE CDU Scratchpad Message Displayed:

Progress Page 2SELECT

Totalizer SELECT USE

Totalizer **USE** prompt (5L) available only after **FUEL DISAGREE** message displayed on CDU scratchpad.

After engine shutdown, all remaining fuel can be used for the operating engine. Resume normal fuel management procedures.

Plan to land at the nearest suitable airport.

Ground Proximity Flap Override Switch.....OVRD

Note: Use flaps 20 and V_{REF} 20 for landing and flaps 5 for go-around.

Note: All remaining fuel can be used for the operating engine. Plan to balance fuel when the **FUEL IMBALANCE** message is displayed.

IF FUEL QTY LOW Message Displayed:

Crossfeed Switch (Either).....ON

Fuel Pump Switches (All)ON

Note: Avoid high nose up attitude and excessive acceleration or deceleration.

Do not accomplish the following checklist:

FUEL QTY LOW

* * * *

(u) GEAR LEVER LOCKED DN

Condition: Landing gear lever cannot be positioned to UP.

Landing Gear Lever Lock Override SwitchPUSH AND HOLD

Landing Gear Lever..... UP

* * * *

(u) NAVAID INHIBIT

GPS position updates are allowed for all United States National Airspace approach operations. Outside of this region, GPS position updates are allowed during approaches only if the FMC database and approach charts are referenced to the WGS-84 reference datum. GPS updates should be inhibited for all other approach operations, unless other appropriate procedures are used.

To Inhibit GPS:

Pos Ref Page 3/3SELECT

POS REF 3/3 is the third page of POS INIT 1/3.

GPS Nav KeyPUSH

Verify GPS NAV OFF selected.

To inhibit VOR's, VOR/DME's, VORTAC's, or DME's:

Init Ref KeyPUSH

Index KeyPUSH

Nav Data KeyPUSH

To inhibit all VOR/DME data:

VOR/DME Nav KeyPUSH

Verify VOR/DME NAV OFF selected.

Enter identifiers of specific navaids or VOR's to be inhibited on the NAVAID INHIBIT or VOR ONLY INHIBIT lines.

* * * *

(u) OVERWEIGHT LANDING

Condition: A landing at greater than maximum landing weight is required.

The autoland system is not certified for overweight landings. Acceptable autoland performance cannot be assured at weights above the certified maximum landing weight.

Note: A return to land on the takeoff runway is always acceptable, due to accelerate stop distance requirements for takeoff.

Runways other than the takeoff runway require checking appropriate Landing Distance Charts in Section 5.

Refer to LANDING CLIMB LIMIT WEIGHT chart.

LANDING CLIMB LIMIT WEIGHT**FLAPS 30**

OAT		AIRPORT PRESSURE ALTITUDE (FT)			
°C	°F	0	1000	2000	3000
54	129	507.3			
50	122	531.7	512.1	492.3	
45	113	565.0	544.1	523.4	503.5
40	104	602.3	578.0	566.0	535.1
35	95	639.1	612.0	590.8	565.7
30	86	663.4	638.7	613.8	589.3
25	77	664.5	648.8	632.7	610.2
20	68	665.6	649.7	633.6	614.6
15	59	666.7	650.8	634.7	615.5
10 & below	50 & below	667.8	667.8	635.6	616.2

Based on engine bleed for 2 packs ON, APU operating, engine anti-ice ON or OFF and wing anti-ice OFF.

With packs off, increase allowable weight by 6100 lbs.

With engine and wing anti-ice ON, decrease allowable weight by 5100 lbs.

Decrease allowable weight by 43250 lbs. for ice accumulation when operating in icing conditions during any part of the flight with forecast landing temperature below 10° C.

IF Landing Gross Weight Greater Than Landing Climb Limit Weight:

▲ Ground Proximity Flap Override Switch OVRD

OR

Note: Use flaps 20 and V_{REF} 20 for landing and flaps 5 for go-around.

* * * *

IF Landing Gross Weight Less Than Landing Climb Limit Weight:

Approach Ref Page SELECT

Gross WT ENTER

Enter estimated landing gross weight.

(Continued)

IF V_{REF} 30 At Or Below 160 Knots:

Note: Use flaps 30 and V_{REF} 30 for landing and flaps 20 for go around.

OR

* * * *

IF V_{REF} 30 Above 160 Knots:

Note: Use flaps 25 and V_{REF} 25 for landing and flaps 20 for go around. This prevents the possibility of flap retraction during the approach due to load relief activation.

* * * *

(u) PACKS OFF TAKEOFF

----- BEFORE TAKEOFF -----

Pack Switches OFF

Wait 30 seconds before setting takeoff thrust. (Allows packs to shut down and EECs time to recompute maximum N_1 line and reference / target N_1 indications.)

Do not accomplish the following checklists:

PACK L
PACK R

----- AFTER TAKEOFF -----

Pack Switches AUTO

After engine thrust is reduced from takeoff to climb and prior to reaching 3000 feet above field elevation, position both PACK switches to AUTO.

* * * *

(u) QFE / METERS OPERATIONS

Condition: Landing or departure from a QFE / metric airport such as Russia or mainland China is necessary. (Altitude assignments at and above the Transition Level are in flight levels QNE / meters. Altitude assignments below the Transition Level are in QFE / meters.)

MCP Altitude Increment Selector AUTO

Set metric altitudes to closest higher MCP altitude in 100 ft increments.
Do not use Altitude Hold in an attempt to fly the exact metric altitude (negates VNAV functions).

BARO Reference Selector HPA

MTRS Switch PUSH

CDU APPROACH REF Page SELECT QFE

Select QFE for LANDING REF

Sets the cabin pressurization schedule.

Sets landing altitude indication to zero altitude.

Enables PFD QFE labeling.

Arms PFD altitude tape to change to green background color upon changing barometric setting between QNE and QFE.

MINS Reference Selector RADIO or BARO

Set appropriate QFE feet values for the approach (cannot set meters).

Barometric Standard Switch PUSH

Push STD button when descending below the Transition Level or climbing above the Transition Altitude.

Note: On the DESCENT FORECAST page, check / modify the correct TRANS LVL, and on the VNAV CLB page check / modify the correct TRANS ALT. These values may not be correctly stored in the FMC database, or may be dependent upon the local HPA pressure setting. With incorrect settings the normal amber colored font reminder will be incorrect.

(Continued)

LNAV DISCONTINUE ONLY AS REQUIRED

LNAV may be used throughout descent and approach provided raw data is cross checked. If there is any significant difference discontinue LNAV and revert to raw data.

LNAV must be discontinued any time there is an active altitude conditional waypoint below the Transition Level (QFE mode incompatibility).

VNAV DISCONTINUE BELOW TRANSITION LEVEL

VNAV must not be used below the Transition Level due to inability to function correctly when QFE mode is selected. FLCH is the preferred mode for departure / arrival maneuvering, while FPA is the preferred mode for the final segment of a non-precision approach.

Note: Controllers in these countries sometimes issue altimeter settings in millimeters and/or with reference to QNH. **Below the Transition Level, insure that you have received an altimeter setting in millibars (HPA) referenced to QFE.**

* * * *

(u) REJECTED TAKEOFF

- Captain..... “REJECT” (C)**
- Thrust Levers IDLE (C)**
- Autothrottles..... OFF (C)**
- Max ReverseINITIATE (C)**
- Brakes..... RTO OR MAX MANUAL (C)**
- Speed BrakesCHECK EXTENDED (C)**

Note: Electronic Checklist begins at this point.

- Tower/Ground.....NOTIFY (F)**

Advise ATC that the takeoff is aborted and request assistance, if applicable.

- Passenger PA “REMAIN SEATED, REMAIN SEATED” (F)**

Advise passengers to remain seated unless immediate evacuation is required.

(CAPTAIN DUTIES)

- Parking BrakeAS REQUIRED (C)**

- Tower / Ground..... CONTACT (C)**

Contact any available resources outside the aircraft for information, which will assist in the evacuation decision. Notify of abnormal aircraft conditions and the decision to evacuate or not.

(FIRST OFFICER DUTIES)

Outflow Valve SwitchesMAN (F)

Select the FWD and AFT outflow valve switches to manual to facilitate depressurizing the aircraft in preparation for evacuation should the Captain confirm the need to evacuate.

Outflow Valve Manual Switches OPEN (F)

Manually open both outflow valves to ensure the aircraft is depressurized for opening passenger entry doors if the Captain confirms the need to evacuate.

Do not accomplish the following checklist:

CABIN ALTITUDE AUTO

IF Evacuation Is Required:



(CAPTAIN DUTIES)

Parking BrakeSET (C)**Fuel Control Switches.....CUTOFF (C)**

Shuts down engines, unlocks engine fire switches and ensures passenger entry door flight locks are unlocked. For the safety of the personnel evacuating, ensure positive shutdown of both engines when the decision is made to evacuate the aircraft.

Passenger Evacuation “EASY VICTOR, EASY VICTOR” (C)

Command the crew to begin evacuation by stating “EASY VICTOR, EASY VICTOR” using the PA system. Do not specify an exit or exits to be used. Flight attendants are trained to evaluate escape potential at each exit and use or block exits based on observed conditions.

OR

(FIRST OFFICER DUTIES)

Engine Fire Switches.....PULL AND ROTATE (F)

Engines: Rotate switches in opposite directions. Rotate to the stop and hold for 1 second. Shuts off combustibles and discharges fire extinguisher bottles to reduce potential risk of fire.

APU Fire Switch..... OVERRIDE, PULL AND ROTATE (F)

APU: Override and rotate switch to the stop and hold for 1 second. Shuts down APU, discharges fire extinguisher bottle to reduce potential risk of fire, and removes electrical power which ensures passenger entry door flight locks are unlocked.

(Continued)

----- CREW EVACUATION DUTIES -----

- Captain: Direct and assist passenger evacuation. Ensure all passengers and crew has evacuated the aircraft.
 F/O: Assist Flight Attendants as necessary to ensure appropriate door open and escape slide activated. Proceed to ground without delay. Evaluate escape routes to coordinate and assist with evacuation. Direct passengers to assembly point.
 IRO/ACM: If qualified, assist Flight Attendants in passenger evacuation.

* * * *

IF Evacuation Is Not Required:

Identify the malfunction and accomplish the appropriate checklist, as required.

----- AFTER PROBLEM IS STABILIZED -----

Do not taxi until the flight attendants verify all passengers are seated and all doors / exits are closed. A brief PA reassuring that the situation is under control and advising of your intentions will assist the cabin crew in controlling the cabin and relieving passenger concerns.

After Landing Checklist.....ACCOMPLISH

Caution: If tire damage is suspected, do not retract flaps.

Brake Temperature Indication

(On GEAR synoptic display).....CHECK

If Rejected Takeoff was initiated above 100 kts or brake temperature indications are rising rapidly toward the caution range:

- Clear the runway as soon as completion of checklist will permit.
- Do not set parking brake.
- Do not return to a congested ramp area.
- Do not allow anyone to approach the landing gear area until temperature indications peak.

Note: Do not set parking brake with indications of 6.6 or greater.

Note: If rejected takeoff initiated above 85 knots, monitor temperature for 15 minutes, cool as required by the peak reading. Cooling time in the chart below begins when indications peak.

(Continued)

Numerical Values	Range Value/ Symbol/ Cooling Time
0 – 2.4	Normal/White/No Cooling Required
2.5	Normal/White/10 Minutes
2.6 – 3.0	Normal/White/20 Minutes
3.1 – 3.5	Normal/White (Hottest Brake) 30 Minutes
3.6 – 3.8	Normal/White (Hottest Brake) 40 Minutes
3.8 – 4.0	Normal/White (Hottest Brake) 50 Minutes
4.1 – 4.5	Normal/White (Hottest Brake) 60 Minutes
4.6 – 5.0	Normal/White (Hottest Brake) 70 Minutes
5.1 – 6.5	Caution/Amber Fuse plugs may melt, delay takeoff, and re-inspect after 1 hour. EICAS: BRAKE TEMP
6.6 or Greater	Caution/Amber Fuse Plug Melt Zone Clear runway immediately - do not set parking brake. Tire and brake replacement may be required. EICAS: BRAKE TEMP

* * * *

REJECTED TAKEOFF PROCEDURE

A Rejected Takeoff (RTO) is a maneuver performed during the takeoff roll to expeditiously stop the aircraft on the runway.

REJECTED TAKEOFF DECISION

At low speeds, (up to approximately 100 knots), the energy level is low, therefore the aircraft should be stopped if an event occurs that would be considered undesirable for continued takeoff. Examples include Master Cautions or Warnings, unusual vibrations, or tire failure.

As the airspeed approaches V_1 , the effort required to stop the aircraft can approach the aircraft's maximum stopping capability. After 100 knots and before V_1 , the takeoff should be rejected only for engine failure, a confirmed unsafe configuration, or other conditions that severely affect the safety of flight. V_1 is the maximum speed at which the RTO should be initiated. Therefore, the decision to stop must be made **prior** to V_1 .

Historically, rejecting a takeoff near V_1 has often resulted in the aircraft coming to a stop beyond the end of the runway. Common causes include initiating the RTO at or after V_1 and failure to use proper procedures (maximum stopping capability).

Do not reject the takeoff after V_1 unless the Captain judges the aircraft incapable of flight. Even if excess runway remains after V_1 , there is no assurance that the brakes and/or reversers will have the capacity to stop the aircraft prior to the end of the runway.

REJECTED TAKEOFF MANEUVER

The Captain is responsible for performing all rejected takeoffs. When the First Officer is making the takeoff, he/she will place both hands on the yoke after initially setting takeoff power and the Captain has assumed control of the throttles. The Captain will be prepared to perform the rejected takeoff maneuver, if required. If a rejected takeoff is required or called for by the Captain prior to the First Officer removing his/her hand from the thrust levers, the First Officer will retard the thrust levers to idle and assist the Captain in the rejected takeoff maneuver.

During the takeoff roll, the Pilot Monitoring will monitor all instruments and indicators. Below 100 knots, any abnormality should be called out. Above 100 knots the only callout normally made is "POWER LOSS". This callout is made when any crewmember observes a confirmed engine power loss. Above 100 knots, other conditions that severely affect the safety of flight should also be considered and, if appropriate, a callout made. If a non-normal is verbalized during the takeoff roll, the Captain will evaluate the situation and make the go / no-go decision. If the Captain elects to continue he/she should clearly and loudly call out "CONTINUE". In this case, the Pilot Flying will continue the takeoff using normal procedures.

If the Captain initiates a reject, he/she will clearly and loudly announce, "REJECT". As the aircraft decelerates, the First Officer should ensure that proper aileron control input is maintained. Additionally, during a First Officer takeoff and after the Captain has assumed control of the thrust levers, the First Officer will relinquish control of the aircraft to the Captain as soon as "REJECT" is heard.

Transition to manual braking should be verbalized with the call "MANUAL BRAKES".

As soon as conditions permit, the First Officer should notify ATC of the rejected takeoff, and make a "REMAIN SEATED", "REMAIN SEATED" announcement to the cabin.

During any rejected takeoff, the Captain should:

- Close the throttles.
- Disconnect autothrottle.
- Apply maximum reverse thrust.
- Ensure that the speedbrakes automatically deploy.
- Use RTO autobrakes (if available) to a complete stop.

In the event the speedbrakes do not deploy, the First Officer will call "SPEEDBRAKES" and the Captain will manually deploy the speedbrakes. Use RTO brakes or manual braking as required. On a wet or slippery runway, or takeoff at or near maximum runway limit weight, an aborted takeoff at or near V_1 will require MAXIMUM use of all deceleration devices until reaching a full stop.

Whenever a decision is made to reject a takeoff, the following limiting criteria must be considered: weather conditions, runway length and conditions, aircraft weight and takeoff performance limits, and MEL/CDL items affecting aircraft performance.

REJECTED TAKEOFF CONSIDERATIONS	
Below 100 Knots	Above 100 Knots
<ul style="list-style-type: none"> • Engine Failure / Fire • Unsafe / Unable to Fly • Cabin Smoke / Fire • System Failure • Unusual Noise or Vibration • Tire Failure • Abnormal Acceleration • Takeoff Configuration Warning • Windshear Warning 	<ul style="list-style-type: none"> • Engine Failure • Unsafe / Unable to Fly <p>Caution: For the B777 <i>any takeoff configuration warning</i> (such as CONFIG DOORS, CONFIG FLAPS, etc.) should be considered as an "Unsafe to Fly" condition.</p>

Once the aircraft has slowed to a safe speed, it is up to the Captain:

- When and where to exit the active runway.
- When and if to set the parking brake.
- To make a decision whether to evacuate the aircraft, return to the gate, or return for takeoff. Additional information may be required.

In order to determine the best course of action, the following factors should be considered:

- What was the reason for the rejected takeoff – a mechanical problem, an ATC call, etc?
- What is the overall status of the aircraft – is it able to safely taxi?
- What is the status of the F/As, passengers and emergency exits – are they seated and are all doors closed?
- Is emergency equipment required, and can they access the aircraft better on the runway or taxiway?
- Is it prudent to set the parking brake while evaluating the situation if the brakes are very hot?
- What are the effects of hot brakes and tires as it pertains to brake fires, blown fuse plugs, and hazards to ground personnel?
- Is there any other relevant information pertinent to assessing the situation?

If there is doubt as to the most appropriate course of action, the aircraft should be stopped straight ahead on the runway until the situation can be resolved. After the aircraft comes to a complete stop, the Captain will call for the **REJECTED TAKEOFF CHECKLIST**.

REJECTED TAKEOFF DUTIES

During takeoff, the crewmember recognizing the malfunction will call it out clearly and precisely.

CAPTAIN	FIRST OFFICER
<p>Calls “REJECT”</p> <p>Simultaneously brings both thrust levers to idle and disengages the autothrottles.</p> <p>Confirms RTO braking or initiates maximum manual braking.</p> <p>Initiates maximum reverse thrust consistent with runway and aircraft conditions.</p> <p>Raise speedbrake lever if not already up.</p> <p>Announces “MANUAL BRAKES” when autobrakes disengage.</p> <p>Calls for “REJECTED TAKEOFF CHECKLIST.”</p>	<p>Confirms the following actions:</p> <ul style="list-style-type: none"> • Both thrust levers idle. • Autothrottles disengaged. • RTO or manual brakes. • Reverse thrust. • (Calls if other than both reversers operating normally, such as “LEFT REVERSER ONLY.”) • Speedbrake lever full up. (If speedbrake lever is not up calls “SPEEDBRAKES.”) <p>Call “80 KNOTS.”</p> <p>Calls “MANUAL BRAKES” if not called by the Captain.</p> <p>Contact Tower/Ground of reject and status.</p> <p>Notify cabin to “REMAIN SEATED, REMAIN SEATED.”</p> <p>Reads REJECTED TAKEOFF checklist.</p>

* * * *

(u) SMOKE / FUMES AIR COND

Condition: A concentration of air conditioning smoke / fumes is identified.

Oxygen Masks And Smoke Goggles (If Required)ON

Crew Communications (If Required) ESTABLISH

Recirculation Fan SwitchesOFF

Removes fans as a possible source of smoke. Stops recirculation of smoke and increases fresh air flow.

APU Bleed SwitchOFF

Removes APU, if running, as a possible source of smoke.

IF Smoke / Fumes Continues:

Center Bleed Isolation SwitchOFF

Isolates left and right sides of the bleed air system.

Left Pack SwitchOFF

Removes left side of the air conditioning system as a possible source of smoke / fumes.

Left Trim Air SwitchOFF

Removes left side of the trim air system as a possible source of smoke / fumes.

Do not accomplish the following checklists:

PACK L

TRIM AIR L

IF Smoke / Fumes Continues:

Left Pack Switch AUTO

Restores left side of the air conditioning system.

Left Trim Air SwitchON

Restores left side of the trim air system.

(Continued)

Right Pack SwitchOFF

Removes right side of the air conditioning system as a possible source of smoke / fumes.

Right Trim Air SwitchOFF

Removes right side of the trim air system as a possible source of smoke / fumes.

Do not accomplish the following checklists:

PACK R

TRIM AIR R

IF Smoke / Fumes Is Persistent:

Plan to land at the nearest suitable airport.

* * * *

(u) SMOKE / FUMES / FIRE ELEC

Condition: Electrical smoke / fumes / fire is identified.

Oxygen Masks And Smoke Goggles (If Required) ON**Crew Communications (If Required) ESTABLISH****Recirculation Fans Switches (Both) OFF****IF** Smoke / Fumes / Fire Source Known:**Electrical Power (Affected Equipment).....REMOVE****OR**

If practical, remove power from affected equipment by switch or circuit breaker in flight deck or cabin.

IF Smoke / Fumes / Fire Persists Or Source Unknown And Inflight Entertainment System / Passenger Seats And Cabin / Utility Power Switches Installed On Electrical Panel:**Inflight Entertainment System / Passenger Seats Power Switch .. OFF****OR****Cabin / Utility Power Switch..... OFF**

Plan to land at the nearest suitable airport.

* * * *

IF Smoke / Fumes / Fire Persists Or Source Unknown And Inflight Entertainment System / Passenger Seats And Cabin / Utility Power Switches Not Installed On Electrical Panel:**Cabin Reading And Galley Attendant Work Lights ON**

Instruct Flight Attendants to:

- Turn on cabin reading lights switches.
- Turn on galley attendant work lights switches.

Cabin Equipment..... OFF

Instruct Flight Attendants to:

- Turn off galley power switches.
- Turn off cabin fluorescent light switches.
- Turn off main IFE and PC power switches above purser station.

Plan to land at the nearest suitable airport.

* * * *

(u) SMOKE / FUMES REMOVAL

Condition: Smoke / fumes removal is required.

Oxygen Masks And Smoke Goggles (If Required) ON

Crew Communications (If Required) ESTABLISH

Flight Deck Door..... CLOSE

Prevents smoke / fumes from penetrating onto the flight deck.

Recirculation Fans Switches..... OFF

Stops recirculation of smoke / fumes and increases fresh air flow.

Equipment Cooling Switch..... OFF

Attempts to discharge smoke overboard by using the equipment cooling override mode.

Note: After 30 minutes of operation at low altitude and low cabin differential pressure, electronic equipment and displays may fail.

Do not accomplish the following checklist:

EQUIP COOLING OVRD

IF Most Smoke / Fumes Is In Cabin Forward Of Mid-wing And Outflow Valve Manual Control Available:

Aft Outflow Valve Switch..... MAN

Aft Outflow Valve Manual Switch..... CLOSE

Position outflow valve fully closed.

Concentrates smoke / fumes in the forward part of the aircraft and attempts to remove it through the forward outflow valve.

Do not accomplish the following checklist:

OUTFLOW VALVE AFT

OR

* * * *

(Continued)



IF Most Smoke / Fumes Is In Cabin Aft Of Mid-wing And Outflow Valve
Manual Control Available:

Forward Outflow Valve Switch MAN

Forward Outflow Valve Manual Switch CLOSE

Position outflow valve fully closed.

Concentrates smoke / fumes in the aft part of the aircraft and
attempts to remove it through the aft outflow valve.

Do not accomplish the following checklist:

OUTFLOW VALVE FWD

* * * *

(u) VHF DATALINK RADIO RESET

Condition: Right VHF desired as DATA radio or right VHF is selected as
DATA radio and reset to center is desired.

If switching the default radio for suspected datalink reception
problems note that the center VHF radio antenna is located in
the upper mid fuselage area, and the right VHF antenna is
located in the lower aft fuselage area.

Display Select Panel COMM

On the MFD complete the following selections:

MANAGER SELECT

ACARS SELECT

ACARS PG 2 SELECT

ACARS MODE VHF SELECT

MANAGER SELECT

VHF SELECT

DEFAULT RADIO CENTER, RIGHT SELECT
AS APPROPRIATE

(Continued)

DEFAULT RADIO MODE: DATA VERIFY SELECTED
MANAGER SELECT
ACARS..... SELECT
ACARS PG 2 SELECT
ACARS MODE AUTO SELECT
Display Select Panel AS DESIRED

* * * *

(u) VOLCANIC ASH

Condition: Static discharge around the windshield, bright glow in the engine inlets, smoke or dust on the flight deck, or acrid odor indicates the aircraft is in volcanic ash.

Exit volcanic ash as quickly as possible. Consider a 180-degree turn.

Oxygen Mask And Smoke Goggles (If Required).....ON

Crew Communications (If Required) ESTABLISH

Autothrottle Disconnect Switch PUSH

Allows thrust levers to remain where manually positioned.

Thrust Levers CLOSE

Conditions permitting, operate engines at idle.

Reduces possible engine damage and/or flameout by decreasing EGT.

Engine Anti-ice SelectorsON

Increases bleed air extraction to improve engine stall margin.

Wing Anti-ice SelectorON

Increases bleed air extraction to improve engine stall margin.

Recirculation Fan SwitchesOFF

Increases bleed air extraction to improve engine stall margin by putting packs into high flow.

APU Selector (If APU Available)..... START, RELEASE TO ON

Provides an electrical power source in the event one or both engines flame out.

(Continued)

Note: Volcanic ash can cause non-normal system reactions such as:

- Engine malfunctions, increasing EGT, engine stall or flameout
- Decrease or loss of airspeed indications
- **EQUIP COOLING OVRD** indications
- **FIRE CARGO FWD** or **AFT** indications.

IF Engines Flamed Out Or Stalled, Or EGT Rapidly Approaching Or Exceeding Limit:

Fuel Control Switches..... CUTOFF, THEN RUN

Attempts to clear stall condition and allow engines to be put into start mode.

Ram Air Turbine Switch PUSH

Push and hold for 1 second.

Backs up automatic deployment of the RAT.

AirspeedABOVE 270 KTS

Ensures best windmill start capability.

Engines may accelerate to idle slowly. The time from fuel control switch to RUN to stabilized idle may be as long as two and a half minutes. If N_2 is steadily increasing, and EGT remains within limits, the start is progressing normally.

Be aware of possible asymmetrical thrust condition depending upon individual engine start and acceleration times.

When HEAT PITOT L+C+R message displayed:

Primary Flight Computers

Disconnect SwitchDISC, THEN AUTO

Restores flight control normal mode following reversion to secondary mode caused by loss of pitot heat.

Autopilot can be re-engaged when flight control normal mode is restored.

Plan to land at the nearest suitable airport.

* * * *

(u) WINDOW DAMAGE L, R

Condition: Window 1L or 1R arcing, delamination, shattered, or cracked condition is visually identified.

IF Window Arcing, Shattered, Or Cracked:

Forward Window Heat Switch (Affected Window).....OFF

Delamination, shattering, or cracking of the outer pane of the windshield does not affect the pressurization capability of the window.

Do not accomplish the following checklist:

WINDOW HEAT FWD

* * * *

INTENTIONALLY LEFT BLANK

2.1 - AIRPLANE GENERAL**TABLE OF CONTENTS**

CREW OXYGEN LOW	1
<input type="checkbox"/> DOOR AFT CARGO	1
<input type="checkbox"/> DOOR BULK CARGO.....	2
<input type="checkbox"/> DOOR E/E ACCESS	2
<input type="checkbox"/> DOOR ENTRY 1-4L, R	2
<input type="checkbox"/> DOOR FWD ACCESS	3
<input type="checkbox"/> DOOR FWD CARGO.....	3
DOORS.....	4
EMER LIGHTS	4
PASS OXYGEN ON	4

INTENTIONALLY LEFT BLANK

CREW OXYGEN LOW

Condition: Crew oxygen pressure is low.

* * * *

<input type="checkbox"/> DOOR AFT CARGO
--

Condition: Aft cargo door is not closed and latched and locked.

Landing Altitude Selector PULL, SET 8000

Reduces cabin differential pressure to decrease risk of door separation.

IF Aircraft Altitude at or below 8000 feet:



Level Off.....INITIATE

Level off at lowest safe altitude

After level off allow sufficient time for cabin altitude to stabilize.

Minimizes passenger discomfort from effects of cabin depressurization.

OR



IF Aircraft altitude above 8000 feet:

Descent.....INITIATE

Descend to lowest safe altitude or 8000 feet, whichever is higher.

Reduces cabin differential pressure.

After level off allow sufficient time for cabin altitude to stabilize.

Minimizes passenger discomfort from effects of cabin depressurization.

Outflow Valve Switches MAN

Outflow Valve Manual Switches.....OPEN

Position outflow valves fully open to depressurize aircraft.

Once depressurized, the crew may change altitude as necessary.

Do not accomplish the following checklists:

CABIN ALTITUDE AUTO

LANDING ALTITUDE

* * * *

☐ **DOOR BULK CARGO**

Condition: Bulk cargo door is not closed and latched and locked.

Note: The door is in a safe configuration as long as cabin pressurization is normal.

Positive cabin differential pressure ensures door remains in place.

* * * *

☐ **DOOR E/E ACCESS**

Condition: Electrical and electronic access door is not closed and latched and locked.

Note: The door is in a safe configuration as long as cabin pressurization is normal.

Positive cabin differential pressure ensures door remains in place.

* * * *

☐ **DOOR ENTRY 1-4L, R**

Condition: Entry door is not closed and latched and locked.

Note: The door is in a safe configuration as long as cabin pressurization is normal.

Positive cabin differential pressure ensures door remains in place.

* * * *

☐ **DOOR FWD ACCESS**

Condition: Forward access door is not closed and latched and locked.

Note: The door is in a safe configuration as long as cabin pressurization is normal.

Positive cabin differential pressure ensures door remains in place.

* * * *

☐ **DOOR FWD CARGO**

Condition: Forward cargo door is not closed and latched and locked.

Landing Altitude Selector PULL, SET 8000

Reduces cabin differential pressure to decrease risk of door separation.

IF Aircraft altitude at or below 8000 feet:

Level Off.....INITIATE

Level off at lowest safe altitude.

OR Allow sufficient time for cabin altitude to stabilize.

Minimizes passenger discomfort from effects of cabin depressurization.

IF Aircraft altitude above 8000 feet:

Descent.....INITIATE

Descend to lowest safe altitude or 8000 feet, whichever is higher.

Reduces cabin differential pressure.

Allow sufficient time for cabin altitude to stabilize.

Minimizes passenger discomfort from effects of cabin depressurization.

Outflow Valve Switches MAN

Outflow Valve Manual Switches..... OPEN

Position outflow valves fully open to depressurize aircraft.

Once depressurized, the crew may change altitude as necessary.

(Continued)

Do not accomplish the following checklists:

CABIN ALTITUDE AUTO

LANDING ALTITUDE

* * * *

DOORS

Condition: Two or more doors are not closed and latched and locked.

* * * *

EMER LIGHTS

Condition: Emergency lighting system has been manually activated or emergency lights switch is OFF.

* * * *

PASS OXYGEN ON

Condition: Passenger oxygen system is activated.

* * * *

2.2 - AIR SYSTEMS**TABLE OF CONTENTS**

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BLEED ISLN OPEN C, L, R	1
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BLEED ISLN CLOSED C, L, R

Condition: Isolation valve remains closed when commanded open or bleed isolation switch is OFF.

* * * *

BLEED ISLN OPEN C, L, R

Condition: Isolation valve remains open when commanded closed.

* * * *

☐ **BLEED LEAK BODY**

Condition: High temperature bleed air leak is detected in the body area.

The air supply controller automatically isolates heat source within approximately 3 minutes by closing bleed and isolation valves.

Pilot action will be required when a **BLEED LOSS** message is displayed.

Do not accomplish the following checklists:

HYDRAULIC PRESS DEM C1

HYDRAULIC PRESS DEM C2

* * * *

<input type="checkbox"/> BLEED LEAK L, R

Condition: High temperature bleed air leak is detected in the wing or pack bay area.

The air supply controller automatically isolates heat source within approximately 5 minutes by closing bleed and isolation valves.

Pilot action will be required when a **BLEED LOSS** message is displayed.

Do not accomplish the following checklists:

PACK

HYDRAULIC PRESS DEM

* * * *

<input type="checkbox"/> BLEED LEAK STRUT L, R

Condition: High temperature bleed air leak is detected in the strut area.

The air supply controller automatically isolates heat source by closing bleed and isolation valves.

Do not accomplish the following checklist:

PACK L, R

IF After 1 Minute, **BLEED LEAK STRUT** Message Remains Displayed:

Auto Throttle Arm Switch OFF

Allows thrust lever to remain where manually positioned.

Thrust LeverRETARD

Retard slowly until the **BLEED LEAK STRUT** message is no longer displayed or the thrust lever is closed.

Reduces flow of bleed air through the leak.

Ground Proximity Flap Override SwitchOVRD

Note: Use flaps 20 and V_{REF} 20 for landing and flaps 5 for go-around.

IF **BLEED LEAK STRUT** Message Remains Displayed:

Transponder Mode Selector TA ONLY

Prevents climb commands which can exceed single engine performance capability.

Ground Proximity Flap Override SwitchOVRD

Note: Operate engine at idle for remainder of flight.

Note: Use flaps 20 and V_{REF} 20 for landing and flaps 5 for go-around.

* * * *

☐ **BLEED LOSS BODY**

Condition: Bleed air from the left and right body ducts is no longer available.

C1 And C2 Demand Pump Selectors OFF

Prevents display of **HYD PRESS DEM C1** and **HYD PRESS DEM C2** messages while configuring flaps during approach.

Note: Gear retraction time increases to approximately 3 minutes due to reduced center hydraulic system capacity. **HYD PRESS SYS C** and **GEAR DISAGREE** messages will be displayed during retraction.

Do not accomplish the following checklists:

HYD PRESS DEM C1
HYD PRESS DEM C2

* * * *

☐ **BLEED LOSS BODY L**

Condition: Bleed air from the left body duct is no longer available.

C1 Demand Pump Selector OFF

Prevents display of **HYD PRESS DEM C1** message while configuring flaps during approach.

Do not accomplish the following checklist:

HYD PRESS DEM C1

* * * *

☐ **BLEED LOSS BODY R**

Condition: Bleed air from the right body duct is no longer available.

C2 Demand Pump Selector OFF

Prevents display of **HYD PRESS DEM C2** message while configuring flaps during approach.

Do not accomplish the following checklist:

HYD PRESS DEM C2

* * * *

☐ **BLEED LOSS WING L, R**

Condition: Bleed air from the wing duct is no longer available.

Wing Anti-ice Selector..... OFF

Prevents possible asymmetrical ice buildup on the wings.

Do not accomplish the following checklist:

PACK

* * * *

BLEED OFF APU

Condition: APU bleed valve is closed for a system fault or APU bleed switch is OFF.

* * * *

BLEED OFF ENG L, R

Condition: Engine bleed valve is closed for a system fault or engine bleed switch is OFF.

* * * *

**CABIN ALTITUDE**

Condition: Cabin altitude is excessive.

IMMEDIATE ACTION

Oxygen Masks..... ON

Crew Communications..... ESTABLISH

Cabin Altitude And RateCHECK

Confirms pressurization problem.

IF Cabin Altitude Uncontrollable:

Passenger Oxygen SwitchPUSH

Push and hold for 1 second.

Backs up automatic activation of the passenger oxygen system.

DescentACCOMPLISH

Without delay, set lower altitude in the altitude window, engage FLCH, and smoothly extend the speedbrakes. Descend at V_{MO}/M_{MO} if structural integrity is not a factor. Level off at lowest safe altitude or 10,000 feet, whichever is higher.

See Emergency Descent Procedure this section.

* * * *

☐ CABIN ALTITUDE AUTO

Condition: Automatic pressurization control has failed or both outflow valve switches are in manual.

Outflow Valve SwitchesMAN

Outflow Valve Manual Switches..... OPEN/CLOSE

Position as required to control desired cabin rate and altitude. The valve may take up to six seconds to begin moving.

Note: Recommended cabin rate is approximately 500 FPM for climbs and descents.

Note: Recommended cabin altitude in cruise is:

FLIGHT LEVEL	CABIN ALTITUDE
Up To 230	Landing Field Elevation
260	2000
300	4000
350	6000
400 and above	8000

◀ ◀ ◀ ◀ ◀ DEFERRED ITEMS ▶ ▶ ▶ ▶ ▶

==> APPROACH CHECKLIST

- - - - - WHEN AT PATTERN ALTITUDE - - - - -

Outflow Valve Manual Switches..... OPEN

Push and hold for 30 seconds or until outflow valve positions indicate fully open.

* * * *

CARGO HEAT AFT, BULK

Condition: Cargo heat is inoperative or cargo temperature selector is OFF.

* * * *

EMERGENCY DESCENT PROCEDURE

This maneuver is used to bring the aircraft down smoothly to a safe cabin altitude in the minimum time with the least passenger discomfort. It is intended as a specialized case to cover an uncontrollable loss of cabin pressurization. Use of the autopilot is recommended. When it is used for other than pressurization problems or contamination of cabin atmosphere, the oxygen procedures may be omitted.

Don oxygen masks and establish crew communication at the first indication of a loss of cabin pressurization. Verify that cabin pressure is uncontrollable and attempt to determine if there is structural damage. If structural damage is confirmed or suspected, limit airspeed in the descent to current speed or less. If conditions permit, the cabin crew will be advised, on the PA system, of impending rapid descent.

All immediate action items are to be accomplished by memory. Either pilot will call out any items not completed. Perform the entry procedure deliberately and methodically. Do not be distracted from flying the aircraft.

General Considerations

Normally the emergency descent will be made with the landing gear up. The autopilot will normally be used for the descent.

The PM will check minimum enroute altitude, notify ATC, obtain altimeter setting and call out altitudes approaching level off. If not in contact with ATC, squawk 7700. Level off at 10,000 feet or minimum enroute altitude, whichever is higher. The PM will call out 2,000 feet above and 1,000 feet above level off altitude.

When turbulent air is encountered or expected, reduce to turbulent air penetration speed (280 KIAS or .82 Mach above FL250; 270 KIAS below FL250).

Rapid descent is made with the landing gear up.

Autopilot Entry And Level Off

Flight Level Change (FLCH)

Because of airspeed and altitude protection and reduced crew workload, FLCH is the recommended mode for rapid descents. First set a lower altitude in the altitude window. Engage FLCH and smoothly extend the speedbrakes. Fly straight ahead or initiate a turn using HDG SEL. Autothrottles should be left engaged. The aircraft will pitch down smoothly while the thrust levers retard to idle. Adjust the speed as necessary and ensure the altitude window is correctly set for the level off.

When approaching the target altitude, ensure that the altitude is set in the MCP altitude window. Altitude capture will engage automatically. Adjusting the command speed to approximately LRC or 310 knots prior to level off aids in smoothly transitioning to level flight. Smoothly return the speedbrake lever to the down detent during the level off maneuver. The pitch mode will control altitude and the thrust levers will increase to hold speed.

Vertical Speed Mode (V/S)

V/S may also be used by engaging V/S and setting the V/S initially to 8,000 fpm rate of descent. Extend the speedbrakes. Autothrottles may be left engaged if desired. When approaching target speed, adjust the V/S selector to maintain target speed. If the autothrottle is engaged, do not increase command speed until target speed is reached. This prevents the thrust levers from moving out of the idle position.

When approaching the altitude set in the MCP altitude window, altitude capture will engage automatically. Adjusting the command speed to approximately LRC or 310 knots prior to level off aids in smoothly transitioning to level flight. Smoothly return the speedbrake lever to the down detent during the level off maneuver. The pitch mode will then control altitude and the thrust levers will increase to hold speed.

Manual Entry And Level Off

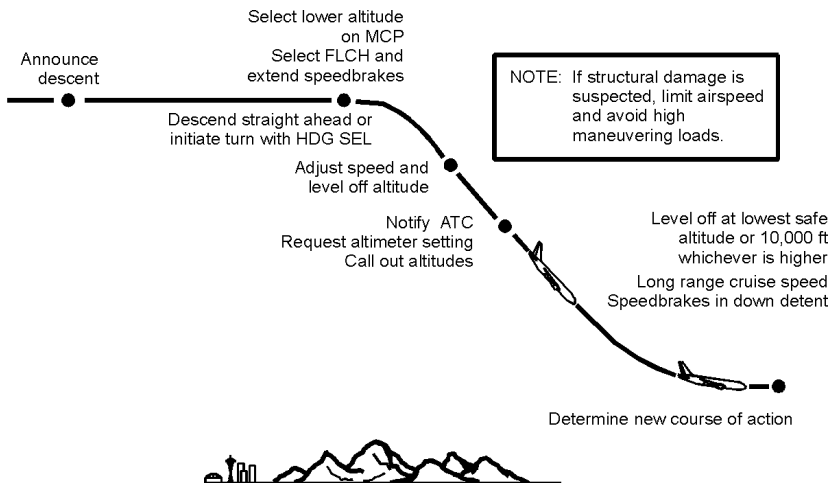
The entry may be accomplished on heading or a turn may be made to clear the airway or controlled track. However, since extending the speedbrakes initially reduces the maneuver margin, it is recommended that turns not be initiated until the aircraft is established in the descent.

To manually fly the maneuver, disconnect the autothrottles and retard thrust levers to idle. Smoothly extend the speed brakes, disconnect the autopilot and smoothly pressure the nose down to initial descent attitude, (approximately 10 degrees nose down).

About 10 knots before reaching target speed, slowly raise the nose to maintain target speed. Keep the aircraft in trim at all times. If $M_{MO}-V_{MO}$ is inadvertently exceeded, change pitch smoothly to decrease speed. Approaching level off altitude, smoothly adjust pitch attitude to reduce the rate of descent. The speedbrake lever should be returned to the down detent when approaching the desired level off altitude. After reaching level flight, add thrust to maintain long-range cruise or other desired speed.

After Level Off

Recheck pressurization system and evaluate the situation. Do not remove the crew oxygen masks if cabin altitude remains above 10,000 feet. Determine the new course of action based on weather, oxygen, fuel remaining and available airports. Obtain a new ATC clearance.



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RAPID DESCENTS

* * * *

EQUIP COOLING

Condition: Forward equipment cooling system is inoperative.

* * * *

☐ **EQUIP COOLING OVRD**

Condition: Equipment cooling system is in override mode.

Wait 2 minutes.

Allows time for any smoke in the system to clear.

Equipment Cooling Switch OFF, THEN AUTO

Attempts reset of the equipment cooling system.

IF EQUIP COOLING OVRD Message Remains Displayed:

Note: After 30 minutes of operation at low altitude and low cabin differential pressure, electronic equipment and displays may fail.

* * * *

☐ **LANDING ALTITUDE**

Condition: FMC has failed to provide a landing altitude or landing altitude selector is pulled.

Landing Altitude Selector PULL, SET MANUALLY

* * * *

☐ **OUTFLOW VALVE AFT, FWD**

Condition: Automatic control has failed or outflow valve switch is in MAN.

Follow this non-normal checklist and attempt to close the outflow valve in manual mode. If the valve moves in the wrong direction, or does not move after 6 seconds of switch activation, leave the affected valve in manual mode and do not make any further attempt to drive the valve in either direction. Depending upon the position of the affected outflow valve, the other outflow valve may not be able to maintain cabin pressurization.

Outflow Valve Switch MAN

Outflow Valve Manual Switch CLOSE

Push and hold for 30 seconds or until outflow valve position indicates fully closed. Valve may take up to 6 seconds to begin moving.

Allows the other outflow valve to take full control of cabin pressure.

* * * *

☐ **PACK L, R**

Condition: Pack is shut down.

Wait 2 minutes.

Allows time for any overheat condition to cool.

Air Conditioning Reset Switch..... ON

Push and hold for 1 second.

Wait 2 minutes.

IF PACK Message Displayed Again:

▲ **Pack Switch..... OFF**

OR

* * * *

▼ **IF Both PACK L and PACK R Messages Displayed Again:**

Pack Switches (Both) OFF

Descent..... ACCOMPLISH

Level off at lowest safe altitude or 10,000 feet, whichever is higher. If flight conditions require, accomplish descent with speedbrake extended at V_{MO}/M_{MO} to prevent excessive cabin altitude.

Outflow Valve Switches (Both)..... MAN

Forward Outflow Valve Manual Switch OPEN

Position outflow valve to 9 o'clock position.

Provides air ventilation to cabin.

Aft Outflow Valve Manual Switch..... OPEN

Position outflow valve fully open.

Provides air ventilation to cabin.

(Continued)

IF Inflight Entertainment System / Passenger Seats and Cabin / Utility Power
 ▲ Switches Installed on Electrical Panel:

Inflight Entertainment System / Passenger Seats Power Switch.. OFF

OR

Cabin / Utility Power Switch..... OFF

Instruct flight attendants to:

- Close cabin window shades during daylight operations.

IF Inflight Entertainment System / Passenger Seats and Cabin / Utility Power
 Switches Not Installed on Electrical Panel:

Cabin Equipment..... OFF

Instruct flight attendants to:

- Turn of galley power switches.
- Turn off main IFE and PC power switches above purser station.
- Reduce cabin lighting to minimum required.
- Close cabin window shades during daylight operations.

Shoulder and Foot Heaters (All)..... OFF

Flight Deck LightingSET

Minimize flight deck lighting intensity to reduce heat.

Flight Deck Door.....OPEN

Plan to land at nearest suitable airport.

Do not accomplish the following checklist:

CABIN ALTITUDE AUTO

* * * *

☐ **PACK MODE L, R**

Condition: Pack is operating in standby mode.

Note: At lower altitudes and/or higher outside air temperatures, the pack may shut down.

Standby mode is not capable of providing cool conditioned air during low altitude, high outside air temperature conditions.

* * * *

☐ **TRIM AIR L, R**

Condition: Trim air is shut off.

Wait 2 minutes.

Allows time for any overheat condition to cool.

Air Conditioning Reset Switch..... PUSH

Push and hold for 1 second.

Wait 2 minutes.

IF TRIM AIR Message Displayed Again:

Trim Air Switch..... OFF

* * * *

2.3 - ANTI-ICE
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<input type="checkbox"/> HEAT PITOT L+C+R	4
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WINDOW HEAT	5
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<input type="checkbox"/> WINDOW HEAT L, R SIDE	6

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☐ **ANTI-ICE ENG L, R**

Condition: Engine anti-ice valve remains closed when commanded open.

Engine Anti-ice Selector OFF, THEN ON

Attempts to manually reset controller and open the valve.

IF **ANTI-ICE ENG** Message No Longer Displayed:

Operate affected engine anti-ice system manually.

Automatic anti-ice is not available for affected engine.

OR

* * * *

IF **ANTI-ICE ENG** Message Remains Displayed:

Engine Anti-ice Selector OFF

Enables **ICING ENG** message to be displayed if icing conditions are encountered.

Note: Avoid icing conditions.

Anti-ice is not available to affected engine because the engine anti-ice system has failed.

* * * *

☐ **ANTI-ICE LEAK ENG L, R**

Condition: High temperature anti-ice bleed air leak is detected in the affected engine.

The engine anti-ice system automatically isolates heat source within approximately 2 minutes by closing the engine anti-ice valve.

Note: Avoid icing conditions.

Anti-ice is not available to affected engine.

IF After 2 Minutes, **ANTI-ICE LEAK ENG** Message Remains Displayed:

Autothrottle Arm Switch.....**OFF**

Allows thrust lever to remain where manually positioned.

Thrust Lever.....**RETARD**

Retard slowly until the **ANTI-ICE LEAK ENG** message is no longer displayed or the thrust lever is closed.

Reduces flow of bleed air through the leak.

IF **ANTI-ICE LEAK ENG** Message Remains Displayed:

Transponder Mode Selector.....**TA ONLY**

Prevents climb commands which can exceed single engine performance capability.

Note: Operate engine at idle for remainder of flight.

Ground Proximity Flap Override Switch**OVRD**

Note: Use flaps 20 and V_{REF} 20 for landing and flaps 5 for go-around.

* * * *

ANTI-ICE LOSS ENG L, R

Condition: Anti-ice bleed air for the affected engine is no longer available.

* * * *

☐ **ANTI-ICE ON**

Condition: Any anti-ice selector is **ON**, TAT is above 10 degrees C, and ice is not detected.

Engine Anti-ice Selectors..... AUTO OR OFF

Wing Anti-ice Selector AUTO OR OFF

* * * *

☐ **ANTI-ICE WING**

Condition: One or both wing anti-ice valves remain closed when commanded open.

Wing Anti-ice Selector..... OFF, THEN ON

Attempts to manually reset controller and open the valve.

IF ANTI-ICE WING Message No Longer Displayed:

Operate wing anti-ice manually.

Automatic anti-ice is not available.

OR

* * * *

IF ANTI-ICE WING Message Remains Displayed:

Wing Anti-ice Selector OFF

Enables **ICING WING** message to be displayed if icing conditions are encountered.

* * * *

☐ **HEAT PITOT C**

Condition: Center pitot probe heat is inoperative.

Note: Standby air data is unreliable in icing conditions.

* * * *

☐ **HEAT PITOT L**

Condition: Left pitot probe heat is inoperative.

Note: ADIRU and SAARU air data is not affected for a single pitot heat failure. Ensure that the right AIR DATA/ATTITUDE SOURCE switch remains OFF.

* * * *

☐ **HEAT PITOT L+C+R**

Condition: All pitot probe heats are inoperative.

Note: Air data is unreliable in icing conditions. See Performance Section 5 for Flight With Unreliable Airspeed.

* * * *

☐ **HEAT PITOT R**

Condition: Right pitot probe heat is inoperative.

Note: ADIRU and SAARU air data is not affected for a single pitot heat failure. Ensure that the left AIR DATA/ATTITUDE SOURCE switch remains OFF.

* * * *

☐ **ICE DETECTORS**

Condition: Ice detection has failed.

Note: Operate engine and wing anti-ice systems manually.

* * * *

ICING ENG

Condition: Ice is detected and one or both engine anti-ice selectors are OFF.

* * * *

ICING WING

Condition: Ice is detected and wing anti-ice selector is OFF, or ice is detected and wing anti-ice takeoff inhibit is active.

* * * *

WINDOW HEAT,

Condition: Two or more window heats are OFF.

* * * *

**WINDOW HEAT L, R FWD**

Condition: Primary window heat for the affected forward window is OFF.

Forward Window Heat SwitchOFF 10 SECONDS, THEN ON

Attempts to reset system.

IF WINDOW HEAT FWD Message Remains Displayed:

Forward Window Heat SwitchOFF

- Removes power to prevent arcing. Window is defogged by the backup system.

* * * *

**WINDOW HEAT L, R SIDE**

Condition: Window heat for the affected side window is OFF.

Side Window Heat SwitchOFF 10 SECONDS, THEN ON

Attempts to reset system.

IF WINDOW HEAT SIDE Message Remains Displayed:

Side Window Heat SwitchOFF

Removes power to prevent arcing.

* * * *

2.4 - AUTO FLIGHT**TABLE OF CONTENTS**

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AUTOTHROTTLE L, R	1
NO AUTOLAND	1
NO LAND 3	1

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AUTOPILOT

Condition: Autopilot is operating in a degraded mode. Engaged roll and/or pitch mode may have failed, or the autopilot has entered envelope protection.

* * * *

AUTOPILOT DISC

Condition: Autopilot has disconnected.

* * * *

AUTOTHROTTLE DISC

Condition: Both autothrottles have disconnected.

* * * *

AUTOTHROTTLE L, R

Condition: Affected autothrottle is OFF or has failed.

* * * *

NO AUTOLAND

Condition: Autoland is not available.

* * * *

NO LAND 3

Condition: Autoland system does not have redundancy for triple channel autoland.

* * * *

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2.5 - COMMUNICATIONS

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DATALINK LOST	1
DATALINK SYS	1
RADIO TRANSMIT	1
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SATCOM DATALINK.....	2
SATCOM VOICE	2
VHF DATALINK.....	2

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ATC DATALINK LOST

Condition: An established ATC datalink has been lost.

* * * *

DATALINK LOST

Condition: Datalink is temporarily lost.

* * * *

DATALINK SYS

Condition: Datalink system has failed.

* * * *

RADIO TRANSMIT

Condition: VHF or HF radio is keyed for 30 seconds or more.

* * * *

SATCOM

Condition: SATCOM system has failed.

* * * *

SATCOM DATALINK

Condition: SATCOM datalink has failed.

* * * *

SATCOM VOICE

Condition: SATCOM voice communication has failed.

* * * *

VHF DATALINK

Condition: VHF datalink has failed.

* * * *

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<input type="checkbox"/> ELEC GEN OFF L, R	6
ELEC GND HDLG BUS	6
ELEC STANDBY SYS	6
MAIN BATTERY DISCH	6

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CIRCUIT BREAKER PROCEDURES

WARNING: Resetting of any tripped fuel boost pump circuit breaker, fuel quantity indication system circuit breaker, or lavatory flush motor circuit breaker is prohibited.

Caution: Due to potential impact on multiple aircraft systems the intentional pulling and resetting of a circuit breaker, other than when specifically directed by a non-normal checklist or appropriate technical authority, is prohibited.

A circuit breaker found in the **out position** may be the result of:

- **Tripped** condition due to an electrical fault.
- Inadvertent pulling out by contact/catching with an object.
- Intentional pulling during a MX/operational procedure and failure to reset.

A **tripped** CB refers to a circuit breaker that was previously verified to be in the normal closed position, then subsequently pops out due to an electrical fault.

Given the significance of any circuit breaker that is found in the **out position**, the following guidelines should be adhered to in order to address the issue:

Preflight Before Block Out:

A circuit breaker that is found in the **out position** during preflight inspection of cockpit preparation (i.e. the crew does not know whether it has tripped or has been pulled out) may be reset one time, unless any of the following conditions are noted:

- There is reason to believe that it has **tripped** due to an electrical fault, or
- The crew heard the CB pop or observed a change in the associated aircraft, system/warning light, which was previously normal but is now unpowered as a result of the CB being out, or
- There is a previous logbook entry about the same CB being **tripped** in the previous 3 calendar days, or
- There is any associated electrical smoke/smell, or evidence of overheating of any aircraft system.

If **any** of the above conditions are noted, *the crew should not reset the CB*, but instead enter the findings in the logbook and call maintenance for investigation prior to departure.

After Block Out and Before Takeoff:

Any CB that is confirmed to have **tripped**, *should not be reset by the crew*. The crew can continue the flight with the CB left in the **tripped** mode, provided the affected system is not required as per the MEL, and all appropriate MEL procedures are complied with. Also there must be no electrical smoke/smell, or evidence of overheating of any aircraft system. In all cases a logbook entry is required.

From Takeoff to Block In:

One reset of a **tripped** circuit breaker may be attempted after a cooling period of approximately two minutes when:

- Called for during a published non-normal/emergency checklist or procedure, or
- At the discretion of the Captain, **provided resetting the CB is necessary for the safe completion of the flight**.

Caution: If the circuit breaker trips again, **do not attempt another reset**.

In all cases a logbook entry is required.

Aircraft Logbook Entries:

All **tripped** circuit breakers regardless of phase of flight and whether reset or not, *must be written up in the aircraft logbook*. This entry should include:

1. Time of occurrence (if known) in Z
2. Aircraft parameters when **trip** occurred (phase of flight, altitude/airspeed)
3. Weather conditions if appropriate
4. Name of the CB
5. Location of the CB
6. Any pilot action that occurred prior to or during the **trip** sequence
7. Attempted reset and results
8. FRM fault codes

Example:

“At 1408Z, during climbout, 15,000 MSL, 290 KIAS, VMC conditions, the RT PITOT HT CB, location D-18, tripped open. Flight continued and no reset of the CB attempted.

FRM code 123-123-12”

☐ **ELEC AC BUS L, R**

Condition: AC bus is unpowered.

Generator Control Switch..... OFF, THEN ON

Attempt only one reset.

IF ELEC AC BUS Message Remains Displayed:

APU Selector (If APU Available) **START, RELEASE TO ON**

Provides an additional source of electrical power.

Do not accomplish the following checklist:

ELEC GEN OFF

IF ELEC AC BUS Message Remains Displayed After APU Running:

Bus Tie Switch (Affected Side) **OFF, THEN AUTO**

Attempt only one reset.

IF ELEC AC BUS Message Remains Displayed:

Do not accomplish the following checklists:

WINDOW HEAT

HYD PRESS PRI

* * * *

☐ **ELEC BACKUP GEN L, R**

Condition: Backup generator has failed.

Backup Generator Switch..... **OFF, THEN ON**

Attempt only one reset.

* * * *

☐ ELEC BACKUP SYS

Condition: Backup power system has failed.

Left Backup Generator Switch..... OFF, THEN ON

Attempt only one reset.

Right Backup Generator Switch..... OFF, THEN ON

Attempt only one reset.

* * * *

☐ ELEC BATTERY OFF

Condition: Battery switch is OFF.

* * * *

☐ ELEC BUS ISLN L, R

Condition: Bus tie breaker is open due to an AC electrical system fault or bus isolation switch is OFF.

IF ELEC AC BUS L, R message also displayed:



Accomplish ELEC AC BUS L, R checklist.

OR



IF ELEC AC BUS L, R message not displayed:

* * * *

Bus Tie Switch(s) (Affected Side).....OFF, THEN AUTO

Attempt only one reset.

If the reset is successful, the Bus Tie Switch(s) may only be reset again if the respective ELEC AC BUS L, R checklist must be accomplished.

If **both** ELEC BUS ISLN L and R messages are displayed, and **both** bus ties will not reset, consideration should be given to landing.

* * * *

ELEC CABIN / UTIL OFF

Condition: Cabin / utility power switch is OFF.

* * * *

ELEC IFE / SEATS OFF

Condition: In-flight entertainment system / passenger seats power switch is OFF.

* * * *

☐ **ELEC GEN DRIVE L, R**

Condition: Generator drive oil pressure is low.

Drive Disconnect Switch..... PUSH

Push and hold for 1 second.

Prevents generator drive damage.

APU Selector (If APU Available)..... START, RELEASE TO ON

Provides an additional source of electrical power.

Do not accomplish the following checklist:

ELEC GEN OFF

* * * *

☐ **ELEC GEN OFF APU**

Condition: APU generator control breaker is open.

APU Generator Switch..... OFF, THEN ON

Attempt only one reset.

* * * *

☐ **ELEC GEN OFF L, R**

Condition: Generator control breaker is open.

Generator Control Switch..... OFF, THEN ON

Attempt only one reset.

IF ELEC GEN OFF Message Remains Displayed:

APU Selector (If APU Available) START, RELEASE TO ON

Provides an additional source of electrical power.

* * * *

ELEC GND HDLG BUS

Condition: Ground handling bus relay has failed.

* * * *

ELEC STANDBY SYS

Condition: A fault is detected in the standby power system.

* * * *

MAIN BATTERY DISCH

Condition: Main battery is discharging or hot battery bus is unpowered.

* * * *

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☐ **APU LIMIT**

Condition: APU operation has exceeded a limit.

APU Selector **OFF**

* * * *

☐ **APU SHUTDOWN**

Condition: APU has automatically shut down.

APU Selector **OFF**

Attempts to reset APU controller.

APU Selector **START, RELEASE TO ON**

* * * *

☐ **ENG ANTI-ICE AIR L, R**

Condition: Engine anti-ice capability is degraded.

Note: Avoid icing conditions.

* * * *

☐ **ENG AUTOSTART L, R**

Condition: Autostart has failed to start the engine, or L, R fuel control switch in RUN at low engine RPM with autostart switch OFF.

Fuel Control Switch..... **CUTOFF**

Removes fuel and ignition from the engine.

Start/Ignition Selector..... **NORM**

* * * *

ENG AUTOSTART OFF

Condition: Engine autostart switch is off.

* * * *

ENG CONTROL L, R

Condition: Fault is detected in the affected engine control system.

* * * *

☐ **ENG EEC MODE L, R**

Condition: Control for the affected engine is operating in alternate mode.

Auto Throttle Disconnect Switch..... PUSH

Allows thrust levers to remain where manually positioned.

Thrust Levers..... RETARD TO MID POSITION

Prevents exceeding thrust limits when switching to alternate mode.

EEC Mode Switches OFF

Push one switch at a time.

Ensures both engines operate in alternate mode.

Auto Throttle Engage Switch..... PUSH

Note: Maximum thrust limiting is not available with autothrottle disconnected. Alternate thrust setting information is displayed on N₁ indications.

Do not accomplish the following checklist:

ENG EEC MODE (for other engine)

* * * *

☐ **ENG FAIL L, R**

Condition: Engine speed is below idle.

Auto Throttle Arm Switch..... **OFF**

Allows thrust lever to remain where manually positioned.

Thrust Lever **CLOSE**

Assists in recognition of affected engine.

Fuel Control Switch..... **CUTOFF**

Shuts off fuel and allows engine to be put into start mode.

Restart may be attempted if no apparent damage.

IF Restart Desired:

▲ Monitor EGT during start.

Prevents EGT exceedance because autostart allows EGT to exceed the in-flight start limit.

IF **X-BLD** Displayed:

OR

Start/Ignition Selector **START**

Allows air to starter for a crossbleed start.

Fuel Control Switch **RUN**

For autostart OFF, position to RUN at maximum motoring.

IF **X-BLD** Not Displayed:

OR

Fuel Control Switch **RUN**

Engine may accelerate to idle slowly. The time from fuel control switch to RUN to stabilized idle may be as long as two and a half minutes. If N_2 is steadily increasing, and EGT remains within limits, the start is progressing normally.

(Continued)



IF Engine Starts And Operates Normally:

Auto Throttle Arm Switch **ARM**

OR

* * * *

IF Engine Damaged Or Remains Failed:

Fuel Control Switch **CUTOFF**

Returns switch to proper position in case of unsuccessful start attempt.

Start/Ignition Selector **NORM**

Returns selector to proper position in case of unsuccessful start attempt.

APU Selector (If APU Available) **START, RELEASE TO ON**

Provides an additional source of electrical power.

Transponder Mode Selector **TA ONLY**

Prevents climb commands which can exceed single engine performance capability.

Plan to land at the nearest suitable airport.

Ground Proximity Flap Override Switch **OVRD**

Note: Use flaps 20 and V_{REF} 20 for landing and flaps 5 for go-around.

* * * *

ENGINE FAILURE AFTER V₁

Note: Either pilot should call “POWER LOSS” when engine failure is recognized and confirmed.

PILOT FLYING (PF)	PILOT MONITORING (PM)
Maintain directional control, rotate to takeoff attitude at V _R .	Call “ROTATE” at V _R .
When a positive rate of climb is indicated, call “POSITIVE RATE, GEAR UP.”	Call “POSITIVE RATE,” if not called by the PF, when positive rate of climb indicated. Position the landing gear lever UP on command.
Climb at V ₂ . Do not exceed bank angle commanded by flight director.*	Monitor engine and flight instruments.
400 feet AGL, call for the appropriate roll mode. “HDG SEL” or “LNAV.”	Select (and/or verify) that the appropriate roll mode is selected and annunciated. HDG SEL or LNAV. If not called for by PF call “400 feet”.
VNAV Annunciated At engine out acceleration altitude call “CHECK TOP BUG.” Retract flaps on schedule. **	Verify top bug. Retract flaps on command. Monitor flap indications. Verify CON is displayed on the EICAS.
VNAV Not Annunciated At engine out acceleration altitude, call “CHECK TOP BUG.” Retract flaps on schedule. When flaps are retracted, call “CONTINUOUS THRUST.” **	Set top bug on command. Retract flaps on command. Monitor flap indications. Select CON power on the MCP and verify CON is displayed on the EICAS.
After flap retraction, when appropriate call for the required checklist.***	Complete the appropriate checklist on command.
Determine the next course of action.	Advise ATC of the Captain’s intentions.

Note: If a fire is indicated, the appropriate checklist may be called for by the PF and executed by the PM after flap retraction is initiated.

- * If an engine failure occurs prior to V_2 , maintain V_2 up to the altitude required for obstacle clearance. If an engine failure occurs after V_2 but less than $V_2 + 15$ knots, maintain the speed reached at the time of the engine failure. If an engine failure occurs at a speed higher than $V_2 + 15$ knots with the flaps at takeoff setting, increase pitch attitude to reduce speed to and maintain $V_2 + 15$ knots until clear of obstacles.
- ** Normally engine out acceleration after an engine failure occurs at 800 feet AGL. Obstacle clearance requirements may define non-standard engine out acceleration and/or flap retraction altitudes. If non-standard altitudes are required, they will be noted on the 10-7 page or in the RMKS section of the ACCULOAD. The crew is required to adjust the Engine out acceleration height on TAKEOFF REF page 2/2 line 1R.
- *** Items the crew considers should include, but not be limited to:
 - Terrain considerations
 - Weather considerations
 - Crew workload management
 - Diversion considerations
 - Use of the autopilot as soon as practical will reduce workload and improves crew coordination.

Rotation and Initial Climb (Single Engine)

Pilot reaction to an engine failure on takeoff should be the same as when experiencing engine failure at other times. Use rudder to maintain the desired heading or track. With TAC, the rudder input required by the pilot is less. Smoothly apply rudder proportionate to thrust decay. At V_R rotate with a smooth ($2^\circ/\text{sec.}$), continuous motion to a target pitch attitude of 10° . Liftoff may occur at a pitch attitude greater than with all engines operating. Retract the landing gear after a positive rate of climb is indicated and called by either pilot. Adjust pitch attitude, as required, to maintain desired airspeed of V_2 to $V_2 + 15$.

WARNING: Do not rotate early or rapidly. Early or rapid rotation increases the risk of aft body contact (tail strike). Late or slow rotation increases the takeoff ground roll. Either improper rotation technique reduces initial climb performance and obstacle clearance margins.

For minimum drag adjust rudder as necessary to maintain a constant heading and control wheel centered.

At engine out acceleration altitude (800 AFE or as required by special engine-out procedure), the PF will call, "CHECK TOP BUG." If not called the PM will call "800'(as appropriate)." The PM will set airspeed cursor to clean maneuvering speed if necessary. At the engine out flap acceleration height, with VNAV engaged, a near-level climb segment is commanded for acceleration. Retract the flaps on the flap-speed schedule. Engine-out acceleration and climb capability for flap retraction are functions of aircraft thrust to weight ratio. The AFDS will command a near level flap retraction segment.

Note: At lower gross weights, acceleration and climb capability will be significantly higher.

If the Flight Director is not being used at flap retraction altitude, decrease pitch attitude to maintain approximately level flight while accelerating. Retract flaps on schedule.

As the aircraft accelerates and flaps are retracted, adjust the rudder pedal position to maintain the control wheel centered and trim to relieve rudder pedal pressure. With TAC, very little rudder trim will be required to keep the control wheel centered.

With an engine inoperative, the AFDS limits the bank angle (in AUTO bank limit) to 15 degrees until $V_2 + 10$ then increases gradually to 25 degrees at $V_2 + 20$. If full maneuvering capability is required, select the desired bank angle on the bank angle limit selector.

The Captain will determine whether to return for landing or continue to an alternate airport.

If the decision is made to return, the Captain may consider maintaining an interim flap setting while maneuvering for another approach. If the decision is to continue to another airport, flaps should be retracted on schedule.

Upon reaching maneuvering speed for the desired flap setting the crew should consider the following prior to completing any checklists:

- Terrain
- Weather
- Crew workload management
- Diversion or return to departure airport
- Use of the autopilot to reduce workload (autopilot may be engaged as soon as the aircraft is in trim at the maneuvering speed for the desired flap setting and the altitude is greater than 1000' above field elevation).

If an engine fire occurs prior to 800 ft. AFE (or obstacle clearance altitude as per 10-7 page), upon reaching obstacle clearance altitude and after flap retraction is initiated, the PF may call for the appropriate pitch mode as well as the appropriate checklist. This will allow the aircraft to accelerate, and will begin the management of the emergency in a timely fashion. The PM should accomplish the appropriate checklist.

Note: In situations where departure procedures require a close-in turn or minimum climb gradient profile, maintain takeoff flap setting and V_2 to $V_2 + 15$ until those conditions have been satisfied. Climb performance is slightly reduced while turning but is accounted for in the special engine out procedure.

Continue climb at applicable maneuvering speed.

Note: When making a reduced thrust takeoff, all performance requirements are met with reduced thrust. If desired, the operating engine may be increased to go-around thrust to improve performance.

FMS ENGINE OUT CAPABILITIES AND FEATURES

The FMS pop-up engine out capability provides for engine out departure procedures that utilize the advanced automation features of the B777 FMS system. These features combine a high degree of vertical and lateral track accuracy to provide a safe escape path in the event of an engine failure during takeoff or go-around.

Section 6.11 of the B777 Flight Manual, FLT MGT NAV, describes the FMS display and selection capability for an airline defined engine out SID (EO SID) for each runway in the navigation database. The EO SID for the selected runway may be viewed by selecting:

- **DEP / ARR INDEX**
- **DEP (RTE 1 or RTE 2)**
- **RUNWAY**
- **EOXXSID** – The last item under **SIDS** is the header **EO SIDS**. If an EO SID is stored it is found under this header. If there is no stored EO SID, **-NONE-** appears.

Manual or automatic selection of an EO SID results in appropriate modifications to the **RTE** and **LEGS** page, and the ND presentation displays the desired lateral track to be flown in the event of an engine failure. The track is displayed as a white modified route until it is executed and becomes magenta.

An EO SID automatically displays during the following conditions:

- VNAV is in the takeoff phase, and
- the flaps are not up, and
- an engine failure is sensed (10% or greater difference in N₂ values).

When displayed the EO SID is reflected as a modification to the active route, but not automatically executed. The **ENG OUT SID MOD** scratchpad message displays.

Engine failures during go-around / missed approach do not automatically display the EO SID. If desired it must be selected as a **DEP, EO SID** in **RTE 2** by denoting the arrival airport as a departure airport in order to gain access to the SID.

With VNAV selected for takeoff, engine out vertical path guidance and appropriate thrust commands occur automatically without pilot intervention regardless of whether or not there is an EO SID available.

The flight crew may select, execute, or erase an EO SID during any phase of flight. Selection of the **ENG OUT** prompt on the VNAV climb and cruise, or alternate airport pages does not display an EO SID procedure.

Departure Setup Procedures

Specific procedures for FMC setup are contained in the applicable Jeppesen Airport Information (-7), page. The following information is an overview of these procedures.

- Load and execute flight plan routing in RTE 1 (including runway, SID and transition, if applicable).
- On **POS REF 2/3** insert the RNP value from the -7 page. This is required to insure lateral track accuracy. If the actual navigational performance (ANP), of the FMC exceeds this value the EICAS message **NAV UNABLE RNP** displays and, if on the ground, the associated checklist should be accomplished. The EO SID is not approved when this EICAS message is present.
- On **TAKEOFF REF 2/2** enter the appropriate acceleration altitudes.
- Select the **TERR** feature for departure on at least one ND (both NDs if wxR is not required).

- Thoroughly brief and review both the normal and EO SIDs. The EO SID may be displayed on the ND and **LEGS** page as a white modified route by going to the DEP ARR page and selecting the **EOXXXSID**. This provides an excellent visual review of the relationship of the normal SID and the EO SID. Erase this modification after completing the engine out portion of the departure briefing. Do not execute this modification or leave it as an unexecuted route modification, as this would result in replacement of the normal, file / cleared SID. An alternative method to view the EO SID would be to program it into **RTE 2** as the departure SID, in which case the routing would appear as cyan in color on the ND when **RTE 2** is selected.
- Use VNAV/LNAV for takeoff and departure.
- During a normal departure, delete the manually inserted RNP value when accomplishing the after takeoff checklist. This allows the appropriate default RNP values to appear consistent the phase of flight. Failure to do this will likely result in the **NAV UNABLE RNP** EICAS message as the actual navigation performance values of the FMC increase during the remainder of the flight.

In the event of an engine failure, first fly the aircraft using the appropriate engine failure procedures and techniques as outlined in this section. The EO SID automatically displays as a white modified route. The PF should call for the **EOXXXSID** to be **EXEC** by the PM. The engine out route will then turn magenta, with appropriate waypoints displayed on the **LEGS** page and the ND. Simply fly the commands of the flight director, which will provide lateral and vertical path commands to insure the aircraft clears all terrain and obstacles. When aircraft control permits, the PM should advise ATC of the necessity to fly the engine failure procedure.

Arrival Setup Procedures

Some airports have approaches requiring special engine out go around / missed approach procedures. As in departure procedure setup, specific procedures for FMC setup are contained in the applicable Jeppesen Airport Information (-7), page. The following information is an overview of these procedures.

- Prior to descent, thoroughly brief and review both the normal and engine inoperative go-around procedures. Ensure the destination airport is present as the **DEP** airport in **RTE 2**. Under **RTE 2, DEP** select the planned arrival runway as the departure runway and select the **EOXXXSID**. (This is the only way to view or subsequently execute the engine out procedure for a go-around / missed approach, since EO SIDs are not stored as an option on the **ARR** page.) This technique affords an excellent method to view and brief the EO SID by simply selecting **RTE 2** on the CDU, resulting in the cyan inactive route EO SID appearing on the ND and the **RTE 2 LEGS** page of the CDU. After completing the approach briefing, return to **RTE 1** on both CDUs.
- On **POS REF 2/3** insert the RNP value from the -7 page during the in range checklist for the same reasons described in the departure procedures. This value does not have to be deleted after landing since the RNP values reset after shutdown, resulting in the appropriate default settings for the subsequent flight.
- Select the **TERR** feature for arrival on at least one ND (both NDs if **WXR** is not required).

If a go-around / missed approach is required fly the appropriate procedure as outlined on the 10-7 page.

In the event of an engine failure during the go-around / missed approach, first fly the aircraft using the appropriate engine failure procedures and techniques as outlined in this section. The PF should call for the PM to "ACTIVATE AND EXECUTE RTE 2" and verify the appropriate active waypoint. LNAV should be engaged and will now follow the EO SID lateral track. "CHECK TOP BUG" should be called when appropriate and the aircraft cleaned up by use of the prescribed engine inoperative go-around procedures as outlined in this section. When able, the PM should advise ATC of the necessity to fly the engine failure procedure.

VNAV OPERATION - ENGINE FAILURE ON TAKEOFF

Verify that VNAV commands an acceleration at the FMC generated EO ACCEL HT altitude of 800 ft ARE (or higher) by observing that FMC airspeed has changed from the speed at VNAV engagement to one of the following three speeds:

190 kts for 20° flap takeoff	(flap limit speed is 195 kts)
210 kts for 15° flap takeoff	(flap limit speed is 215 kts)
230 kts for 5° flap takeoff	(flap limit speed is 235 kts)

CAUTION: Never allow the current airspeed pointer to be in the red and black maximum airspeed indications on the PFD airspeed tape.

Note: VNAV also commands an acceleration (limited by flap/slats or gear configuration) when the MCP or CDU altitude is captured prior to the altitude entered on TAKEOFF page 2/2.

The PF calls for the next flap retraction schedule when the green flap maneuvering speed number on the airspeed tape is at or below the pointer on the current airspeed window. If the flaps are not positioned to the next flap setting the aircraft accelerates to a speed 5 kts below the current flap limit speed until an altitude is captured (autothrottles control speed), or the flap handle is moved to the next lower flap setting.

When the flaps/slats are retracted VNAV commands an acceleration to the VNAV climb speed of $V_{ref} 30 + 80$ kts.

After the flaps/slats are retracted and the airspeed is $V_{ref} 30 + 78$ kts, the N_1 thrust limit automatically changes to **CON**.

If an engine failure during takeoff occurs above the flap retraction altitude (EO ACCEL HT) the VNAV ACT XXX KT CLB page changes to the ACT VREF + 80 CLB page. This indicates an engine failure has been detected but not verified. The pilot must now select and execute the **ENG OUT** prompt at 5R. The ACT VREF + 80 CLB page changes to the ACT EO CLB page and engine out speed is displayed at 2L as **EO SPD XXX**.

VNAV commands the engine out climb schedule, performance predictions and guidance. The engine out speed is propagated to the T/C and into the engine out cruise segment.

The following information is displayed on the ACT EO CLB page:

- 4R MAX ALT / FL XXX
- 1L CRZ ALT / FL XXX

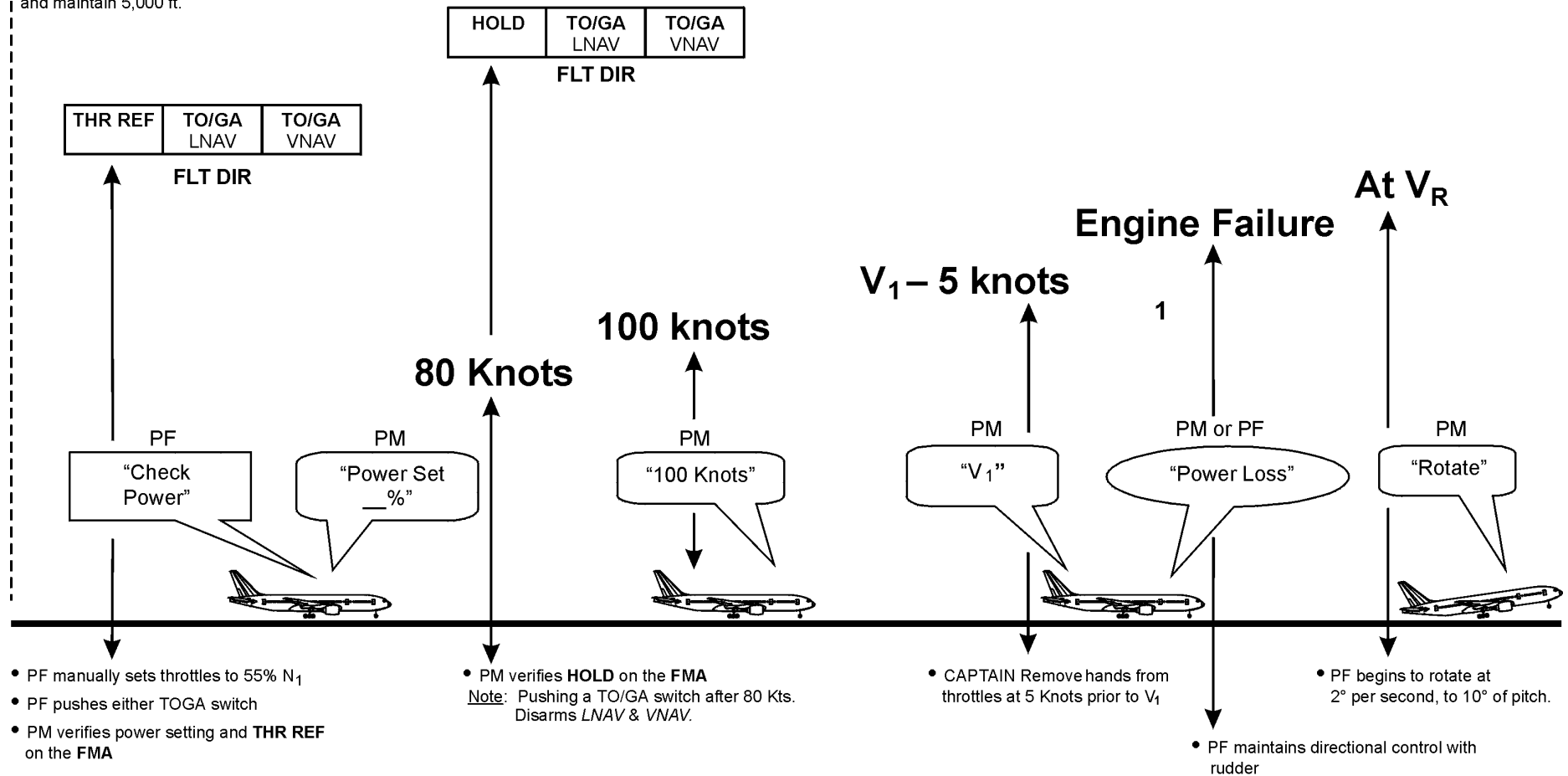
Note: The optimum (**OPT**), maximum (**MAX**), and recommended (**REC**) engine out altitudes are displayed on the ACT EO CRZ page.

When the aircraft reaches the T/C, VNAV transitions to the engine out cruise phase. The VNAV ACT EO CLB page changes to the ACT EO CRZ page with the engine out speed displayed as **EO SPD XXX** at 2L.

Engine Failure On Takeoff Profile (LNAV & VNAV)

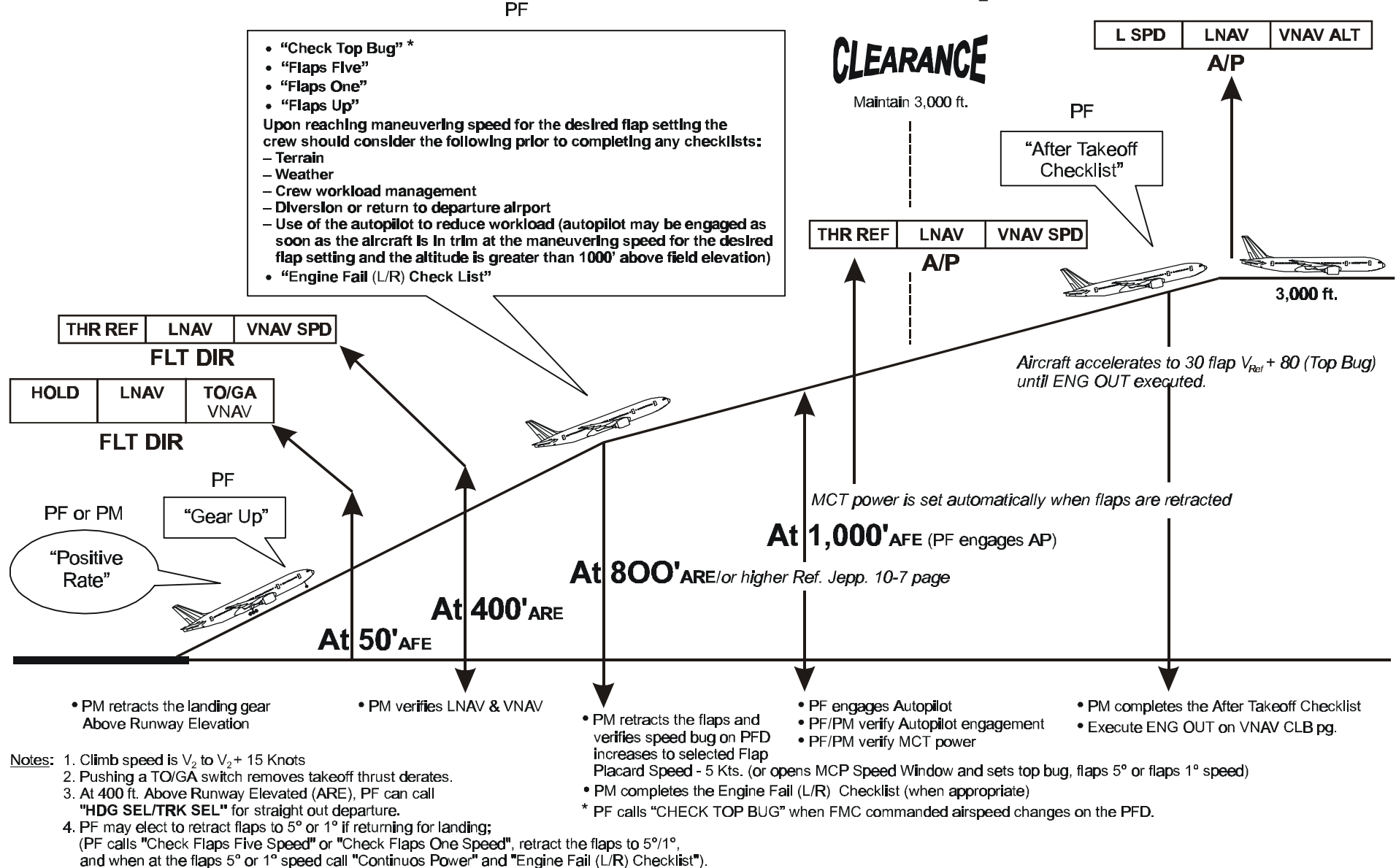
CLEARANCE

Cleared for takeoff, climb and maintain 5,000 ft.



Note: The F/O must keep hand on throttles until takeoff power is set.

Engine Failure On Takeoff Profile (LNAV & VNAV) initial climb (V_2) and acceleration



Engine Inoperative Climb

The engine out climb speed provides maximum angle performance, and varies with gross weight and altitude. At high altitudes and weights, a fixed Mach is used as an upper limit on the engine out climb speed. Engine out climb speed is the FMC default used during climb when ENG OUT CLIMB is selected. Select ENG OUT CLIMB after flaps have retracted and all obstructions are cleared.

If a thrust loss occurs at other than takeoff thrust, set maximum continuous thrust on the operative engine and lower the nose slowly to maintain airspeed as the thrust loss occurs.

In the clean configuration, select the ENG OUT mode (5R) on the CDU climb page. The ENG OUT mode provides VNAV commands to climb at engine out climb speed to cruise altitude or maximum engine out altitude, whichever is lower. If the aircraft is currently above maximum engine out altitude, drift down information is available. Upon reaching level off altitude, the command speed changes to EO SPD. Long Range Cruise (LRC) speed or Company Speed (CO SPD) may be selected. Leave thrust set at maximum continuous thrust until airspeed increases to the commanded value.

Engine Inoperative Cruise

Engine inoperative cruise information is available from the FMC.

If an engine failure occurs while at cruise altitude (after T/C), it may be necessary to descend. On the FMC ACT CRZ page, select ENG OUT. This will display **MOD CRZ** calculated on engine out MCT and maintain the airspeed displayed on the EO SPD line.

Set the EO cruise altitude in the MCP altitude window and execute the EO D/D page. Thrust reference will change to **CON** and the autothrottle will maintain MCT. The aircraft will descend in VNAV using the VNAV SPD pitch mode. Once the descent rate has decreased to 300 fpm during driftdown it is held constant by the FMC until altitude capture.

At altitude capture the ENG OUT CRZ page is displayed. Maintain MCT and driftdown altitude until the EO SPD speed is established.

If the aircraft is at or below maximum EO altitude when an engine becomes inoperative, select and execute the EO CRZ page and maintain engine out cruise speed. If required to cruise at maximum altitude, set MCT and establish a climb, decelerating slowly to EO CLB speed. At level off select EO LRC for best fuel economy.

An alternate target driftdown speed can be selected using the MOD CRZ or EO D/D page. LRC speed would result in a lower driftdown altitude but better fuel performance. A company speed (CO SPD) could be selected.

An EO CRZ ALT can be entered on the MOD CRZ or EO D/D page.

Unless altered by the pilot, the level off cruise mode will be the same as was used during driftdown. FMC fuel and ETA calculations for the driftdown and remainder of the trip will be consistent with the selected speed mode. For best fuel performance select the engine-out LRC mode following a minimum drag speed (E/O) driftdown.

When VNAV is not used during engine out, set MCT on the operative engine and maintain altitude until the aircraft decelerates to the displayed appropriate engine out speed. Use engine out speed from the FMC while descending to the engine out cruise altitude. Remain at MCT until the aircraft accelerates to LRC, then maintain LRC speed. If the FMC is inoperative use turbulence penetration airspeed to drift down and the engine out long-range cruise tables in Section 5.

VNAV OPERATION - ENGINE OUT DRIFT DOWN

Engine out drift down is required when the current aircraft altitude is above the EO MAX CRZ ALT. Several descent profiles are available; however, the following always works and involves the least amount of risk.

1. Select the **ENG OUT** prompt from either the VNAV CLB, CRZ, or ALTN page.
2. Execute the ENG OUT MOD. (Resets VNAV CRZ altitude to the ENG OUT MAX altitude.)
3. Choose an altitude below the ENG OUT altitude and set in MCP altitude window. (i.e., If ENG OUT altitude is 23,200 ft, set 23,000 in window.)
4. Advise ATC of the situation and tell them you are descending to FL230, then push the altitude selector knob.
 - The aircraft begins a VNAV ACT EO D/D CRZ descent to the EO MAX CRZ altitude (reset to 23,000 when altitude selector knob pushed).
 - The aircraft descends at approximately 300 fpm while slowing to the EO drift down speed.
 - Thrust is automatically set to CON.
5. When the diversion plan has been completed (without an EO CRZ flight segment), the pilot may change the speed on the SEL SPD line or choose the **LRC** or **CO SPD** prompt.

Note: If the pilot wants to increase airspeed and descent rate it is necessary to select the VNAV DES page and use the **DES NOW** prompt at 6R. As a result:

- ACT EO D/D page changes to VNAV DES,
- Aircraft accelerates to speed on SEL SPD line,
- Autothrottles may go to HOLD allowing the pilot to adjust as necessary.

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ONE ENGINE INOPERATIVE APPROACH, LANDING AND MISSED APPROACH PROCEDURES
--

Weather minima for all one engine inoperative approaches are the same as for both engines operating.

AFDS management and associated procedures are the same as for a normal approach.

A manually flown ILS requires precise speed control. Allowing airspeed to decrease below the recommended speeds increases drag and could result in inadequate thrust for altitude control.

Under some atmospheric conditions (high temperatures, high pressure altitudes, combined with high aircraft weight), limit thrust may be required to maintain level flight with gear down and flaps 20.

If these conditions are encountered during the circling portion of a one engine inoperative approach, consider retracting the landing gear. The GPWS gear override switch may be used to prevent nuisance warnings. Extend the gear and complete the landing checklist just prior to initiating the descent on the landing profile.

One Engine Inoperative ILS Approach

Intercept the localizer with flaps 5 at the recommended maneuvering speed.

- At 2 dots deflection below the glideslope, the PF will call “FLAPS 20, TARGET” and use the $V_{REF} 20 + 5$ kts.
- At 1 dot deflection below the glideslope the PF will call “GEAR DOWN, LANDING CHECKLIST.” The PM will complete the landing checklist.
- At glideslope intercept the PF will call “TARGET” if required.

An autoland may be accomplished if the quality of the approach is satisfactory. Additional engine-out logic is incorporated during runway alignment to insure the downwind wing is not low at touchdown. If the crosswind is from the side opposite the failed engine, a failed engine high (upwind wing low) attitude is maintained during the approach. An additional sideslip is induced proportional to the engine out crab and the crosswind sideslip (up to 5 degrees), and is additive to the sideslip.

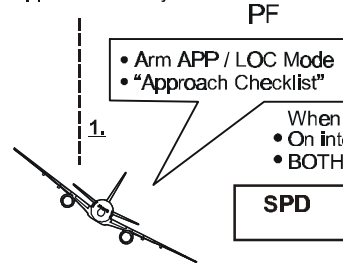
One Engine Inoperative ILS Approach (TAC Inoperative)

When using autopilots for the approach with an engine inoperative use rudder pedal pressure or rudder trim. Below 1,500 foot radio altitude, with localizer and glideslope captured and Land 2 or Land 3 annunciated, rudder inputs are controlled by the autopilots.

In order to maintain wings level on final, in addition to sideslip used for wind correction (up to 1½ degrees), the autopilots may maintain a slight sideslip (up to 1½ degrees). The amount of rudder input is calculated from angle of attack and rudder displacement. The rudder input is “washed out” to zero during the flare. If the autopilots are disconnected, be prepared to maintain required rudder pedal pressure.

CLEARANCE

Turn left heading 030 intercept the localizer maintain 2,000 ft. Until established cleared ILS approach runway 36L



When cleared for the Approach:

- On intercept heading PM selects, as appropriate, the APP / LOC Mode and sets the Glide Slope intercept altitude on the MCP
- BOTH PILOTS verify that the LOC and GS, as appropriate, arm on the FMA and that the Glide Slope intercept altitude is set on the MCP

SPD	HDG SEL	VNAV PTH
	LOC	GS

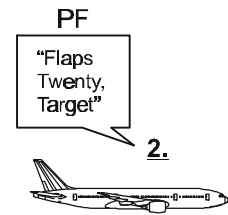
FLT DIR

SPD	LOC	VNAV PTH
		GS

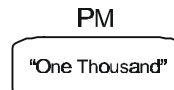
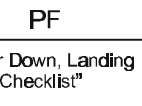
FLT DIR

SPD	LOC	GS
-----	-----	----

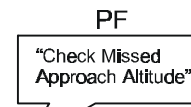
FLT DIR



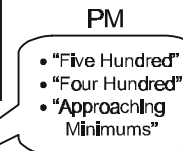
2,000 ft.



At 1,000 ft. TDZE



At 500 ft. TDZE



When PM has visual reference to land the call is:

At 25 ft. RA. ATS to IDLE on FMA



Engine Inoperative Cat I Non-Monitored Manual Profile (VNAV)



- PM selects the flaps to the 5 degree position
- PM sets flaps 5 maneuvering speed in the ATS window on the MCP



- PM selects the flaps to the 1 degree position
- PM sets flaps 1 maneuvering speed in the ATS window on the MCP

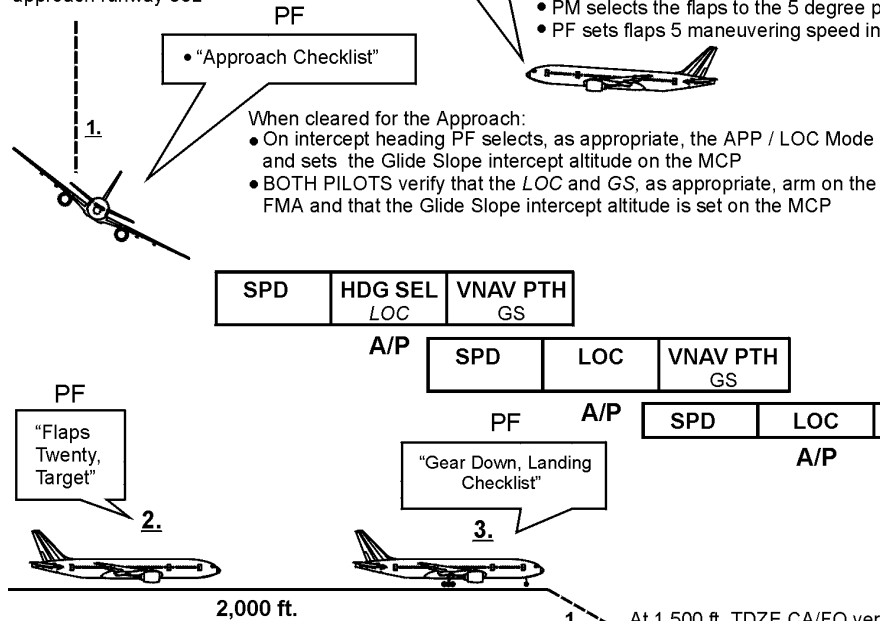


- NOTES:
- If above the GS intercept altitude when cleared for the approach, set the GS intercept altitude (for VNAV) or the next altitude restriction (for FLCH) in the MCP altitude window.
 - If using LOC mode due to altitude constraints arm the APP Mode when level at or descending through the last altitude constraint prior to the GS intercept altitude.

- No later than intercept heading and cleared for the approach
 - PF Calls: "Approach Checklist"
 - PM accomplishes the approach Checklist
- At two dots below glide slope
 - PF Calls: "Flaps Twenty, Target"
 - PM selects the flaps to 20 and sets target speed in the MCP
- At one dot below the glide slope
 - PF Calls: "Gear Down, Landing Checklist"
 - PM places the gear handle down and accomplishes the Landing Checklist
- At 1,000 ft. above TDZE
 - PF Calls: "Check Missed Approach Altitude"
 - PM sets Missed Approach Altitude in the MCP altitude window

CLEARANCE

Turn left heading 030 intercept the localizer maintain 2,000 ft. Until established cleared ILS approach runway 36L

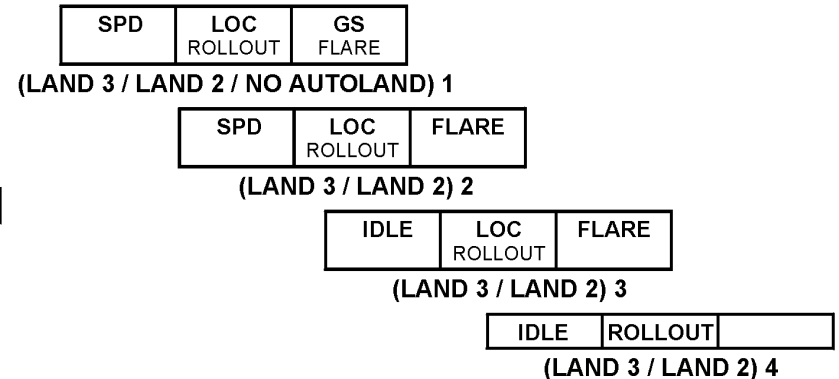
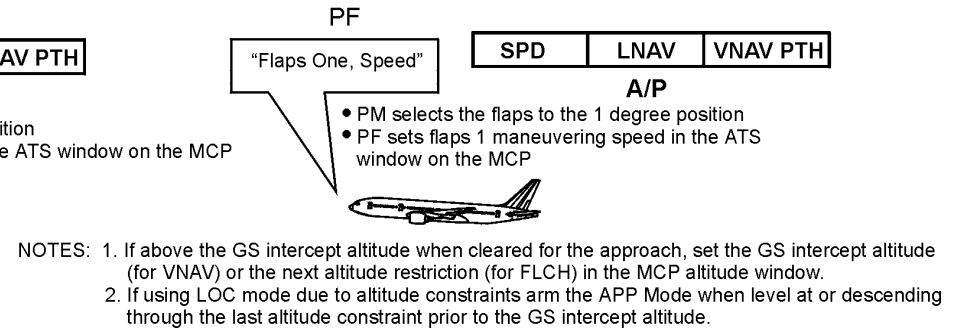


The FO should assume the Flying duties early in the approach (No later than intercept HDG or, for straight in, 3 miles from OM.)

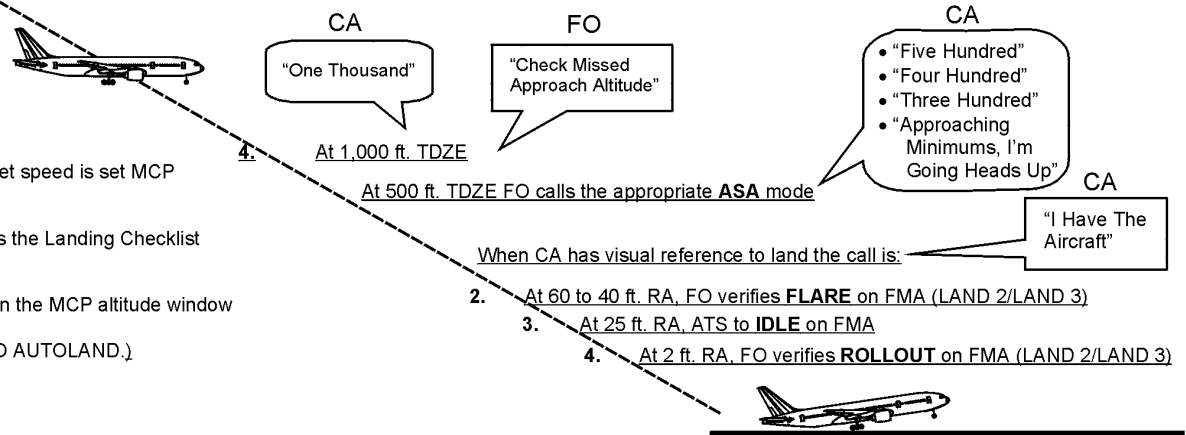
1. No later than intercept heading and cleared for the approach
 • FO Calls: **"Approach Checklist"**
 • CA accomplishes the approach Checklist
2. At two dots below glide slope
 • FO Calls: **"Flaps Twenty, Target"**
 • CA selects the flaps to 20 and verifies that the target speed is set MCP
3. At one dot below the glide slope
 • FO Calls: **"Gear Down, Landing Checklist"**
 • CA places the gear handle down and accomplishes the Landing Checklist
4. At 1,000 ft. above TDZE
 • FO Calls: **"Check Missed Approach Altitude"**
 • CA/FO sets/verifies the Missed Approach Altitude in the MCP altitude window

NOTES: PF must disconnect autopilot at 200 ft. AFE if ASA shows (NO AUTOLAND.)
 For CAT II approach ASA must be **LAND 2 or LAND 3**
 The "Three Hundred" foot call is for a CAT II Approach only.
 At DH the PM Calls: **"Minimums"**

Engine Inoperative CAT I & CAT II Monitored/Coupled Profile (VNAV)

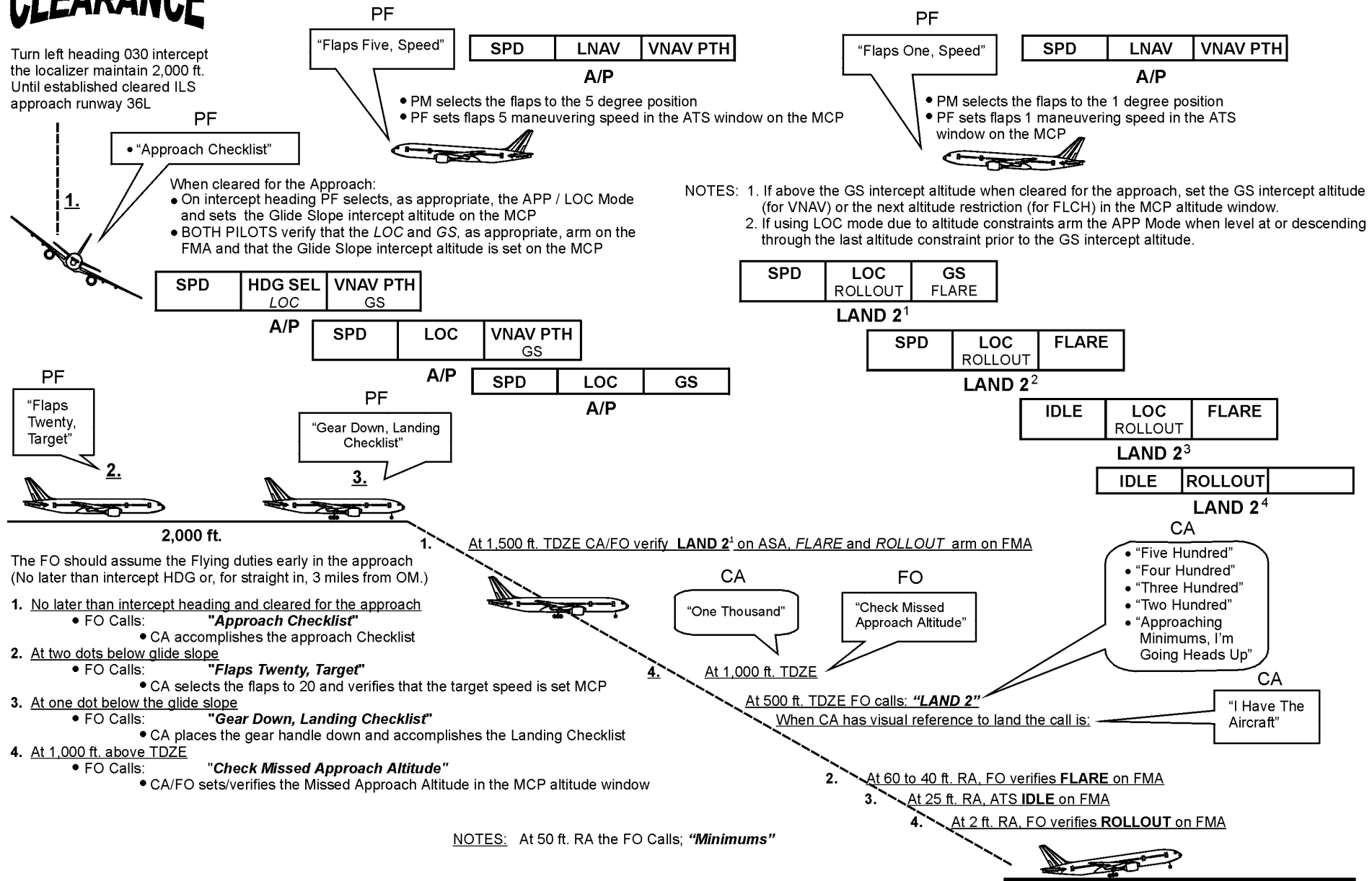


At 1,500 ft. TDZE CA/FO verify LAND 3 / LAND 2 / NO AUTOLAND on ASA. **FLARE** and **ROLLOUT** arm on FMA



CLEARANCE

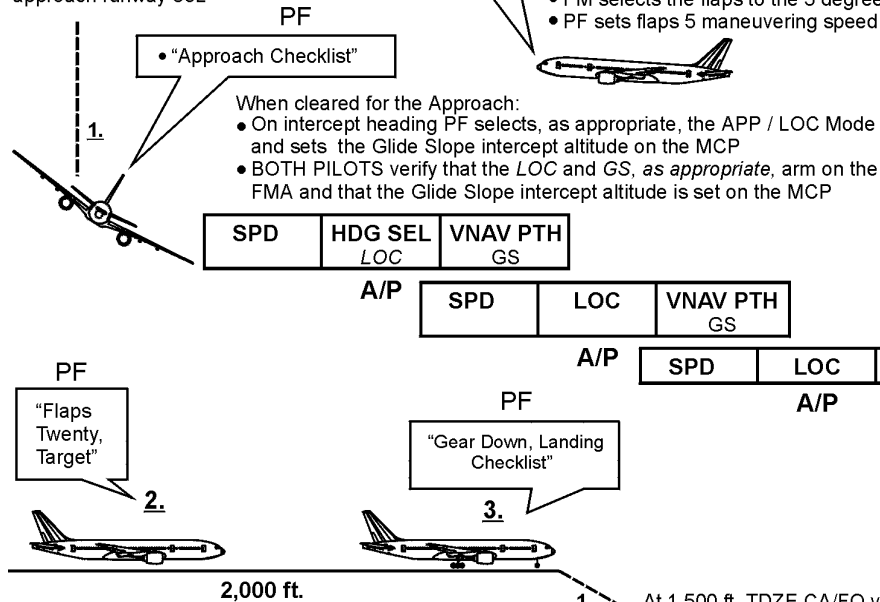
Turn left heading 030 intercept the localizer maintain 2,000 ft. Until established cleared ILS approach runway 36L



CLEARANCE

Engine Inoperative CAT III (LAND 3) Monitored/Coupled Profile (VNAV)

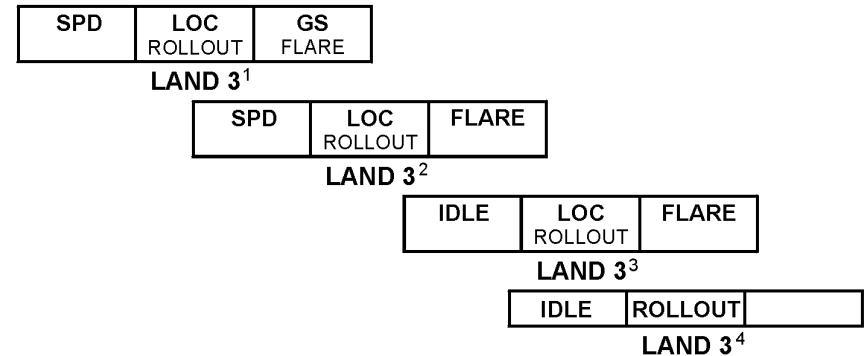
Turn left heading 030 intercept the localizer maintain 2,000 ft. Until established cleared ILS approach runway 36L



The FO should assume the Flying duties early in the approach (No later than intercept HDG or, for straight in, 3 miles from OM.)

- No later than intercept heading and cleared for the approach
 - FO Calls: "Approach Checklist"
 - CA accomplishes the approach Checklist
- At two dots below glide slope
 - FO Calls: "Flaps Twenty, Target"
 - CA selects the flaps to 20 and verifies that the target speed is set MCP
- At one dot below the glide slope
 - FO Calls: "Gear Down, Landing Checklist"
 - CA places the gear handle down and accomplishes the Landing Checklist
- At 1,000 ft. above TDZE
 - FO Calls: "Check Missed Approach Altitude"
 - CA/FO sets/verifies the Missed Approach in the MCP altitude window

- NOTES: 1. If above the GS intercept altitude when cleared for the approach, set the GS intercept altitude (for VNAV) or the next altitude restriction (for FLCH) in the MCP altitude window.
2. If using LOC mode due to altitude constraints arm the APP Mode when level at or descending through the last altitude constraint prior to the GS intercept altitude.



One Engine Inoperative Non-Precision Approach (TAC Operative Or Inoperative)

One engine inoperative non-precision approach's circling approach's and missed approach's are the same as an all engine non-precision approach. The preferred method to fly the path from the Final Approach Fix is VNAV with speed intervention. (If VNAV is not available or desired, then FPA or V/S, in that order of preference.) All one engine inoperative non-precision approaches will be flown using the autopilot (and autothrottles if available).

When flying an approach with TAC operating the rudder control is automatically controlled by TAC with minimal input required from the pilot. When TAC is inoperative, rudder control and rudder trim are the same as with other Boeing aircraft. Keep the rudder in trim at all times.

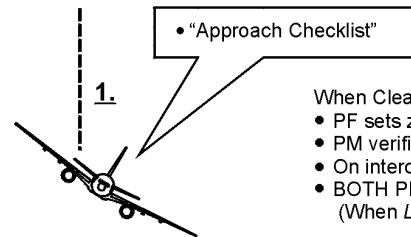
Intercept the final approach course with flaps 5 at the recommended maneuvering speed.

- At 3 miles prior to the FAF, the PF will call "FLAPS 20, TARGET" and use the $V_{REF} 20 + 5$ kts. Minimum speed, providing bank angles will not exceed 15 degrees for the remainder of the approach. If bank angles will exceed 15 degrees, call "FLAPS 20, SPEED" and use the flaps 20 maneuvering speed.
- At 2 miles prior to the FAF, the PF will call "GEAR DOWN, LANDING CHECKLIST." The PM will complete the landing checklist.
- At 1 mile prior to the FAF, the PF will call "TARGET" if required.

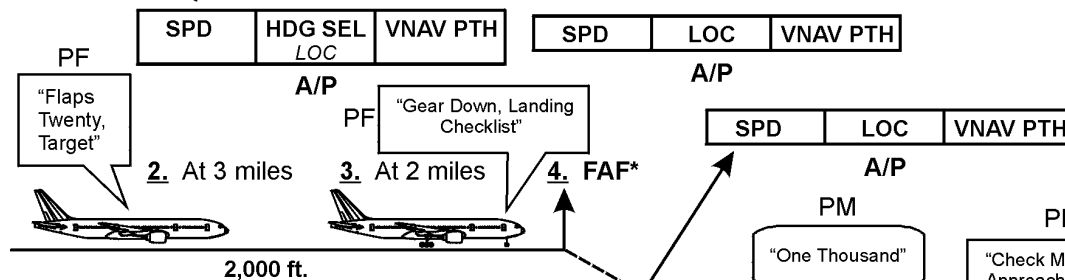
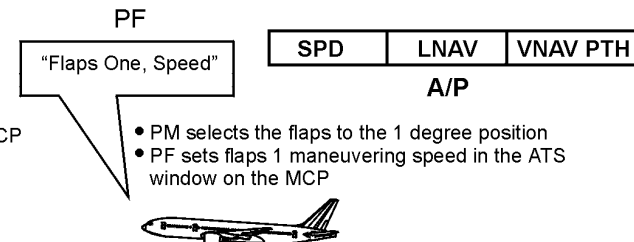
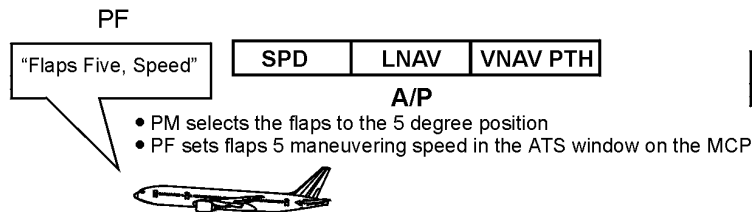
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CLEARANCE

Turn left heading 030 intercept the (LOC) maintain 2,000 ft. Until established cleared (LOC) approach runway 36L



Engine Inoperative Non Precision Coupled Profile (VNAV)



1. No later than intercept heading and cleared for the approach

- PF Calls: **"Approach Checklist"**
- PM accomplishes the approach Checklist

2. At 3 miles from the Final Approach Fix

- PF Calls: **"Flaps Twenty, Target"**
- PM selects the flaps to 20° and verifies that the target is set in the MCP speed window

3. At 2 miles from the Final Approach Fix

- PF Calls: **"Gear Down, Landing Checklist"**
- PM places the gear handle down and accomplishes the Landing Checklist

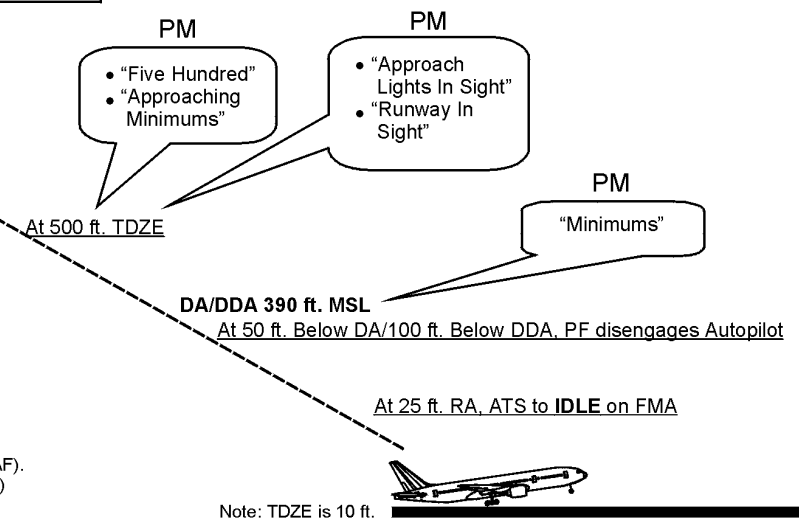
4. At the Final Approach Fix*

- BOTH PILOTS verify that zero is set in the MCP Altitude window and the aircraft begins a Descent to the DA/DDA

5. At 1,000 ft. above TDZE

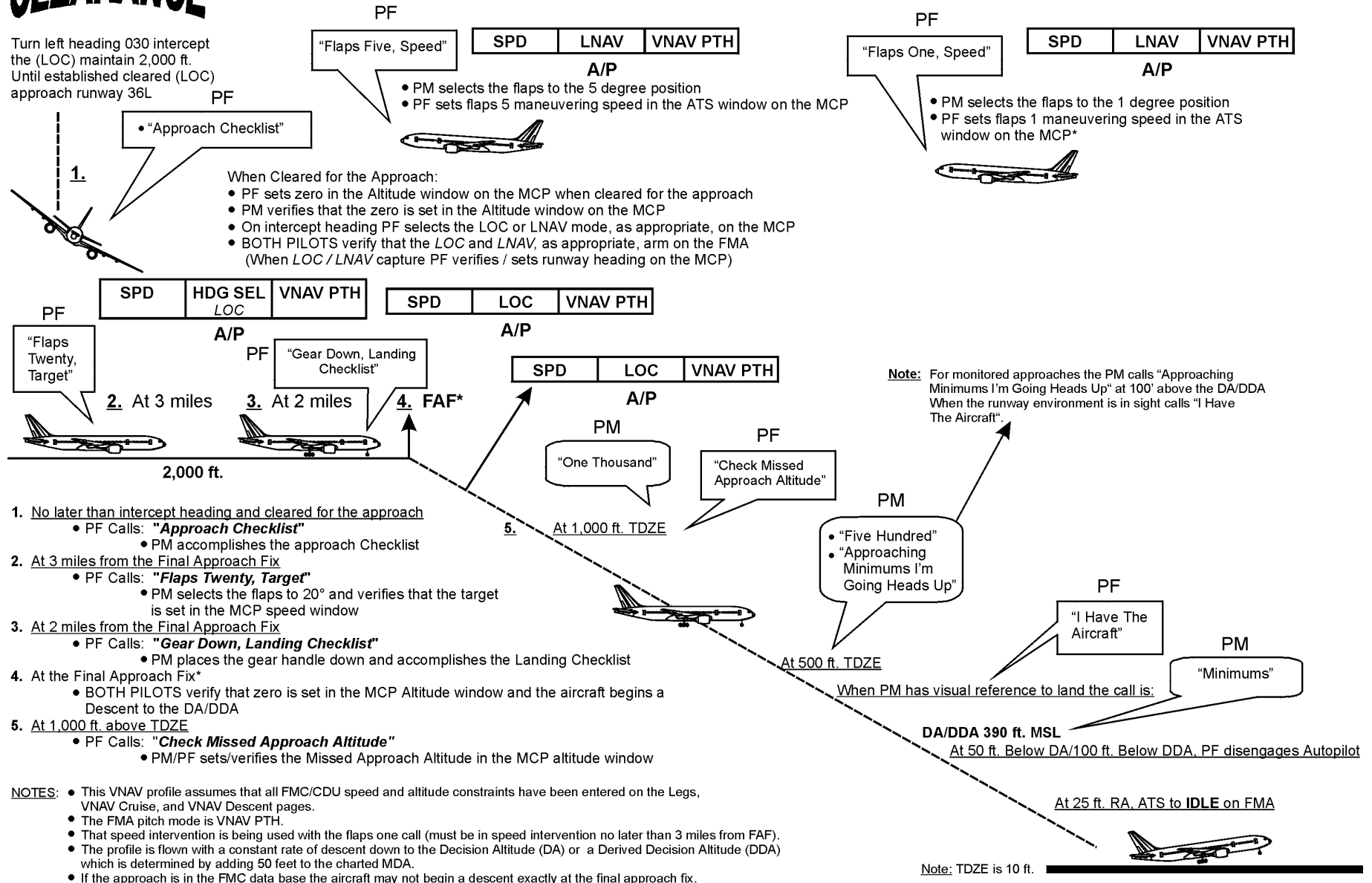
- PF Calls: **"Check Missed Approach Altitude"**
- PM/PF sets/verifies the Missed Approach Altitude in the MCP altitude window

- NOTES:
- This VNAV profile assumes that all FMC/CDU speed and altitude constraints have been entered on the Legs, VNAV Cruise, and VNAV Descent pages.
 - The FMA pitch mode is VNAV PTH.
 - That speed intervention is being used with the flaps one call (must be in speed intervention no later than 3 miles from FAF).
 - The profile is flown with a constant rate of descent down to a Decision Altitude (DA) or a Derived Decision Altitude (DDA) which is determined by adding 50 feet to the charted MDA.
 - If the approach is in the FMC data base the aircraft may not begin a descent exactly at the final approach fix.



CLEARANCE

Engine Inoperative Non Precision Monitored/Coupled Profile (VNAV)



One Engine Inoperative Landing

The flight profile for a one engine inoperative landing is the same as for a normal landing.

Asymmetrical reverse thrust may be used with one engine inoperative. Use normal reversing procedures and techniques. TAC does not operate while using reverse thrust or below 70 KIAS. If directional control becomes marginal during deceleration return the reverse lever to the idle detent. Single engine taxi to the gate is permissible at Captain's discretion.

One Engine Inoperative Landing (TAC Inoperative)

With the TAC inoperative, it may be desirable to trim the rudder to zero to facilitate directional control during thrust reduction and on the runway. This should be accomplished prior to 500 feet AFE to allow the PM ample time to perform other duties and make appropriate altitude callouts.

Centering the rudder trim prior to landing allows most of the rudder pedal pressure to be removed when the thrust of the operating engine is retarded to idle at touchdown. Full rudder authority and rudder pedal steering capability are not affected by the rudder trim. If touchdown occurs with the rudder still trimmed for the approach, be prepared for the higher rudder pedal forces required to track the centerline on rollout.

One Engine Inoperative Missed Approach

When making a one engine inoperative missed approach with TAC operating, the rudder is automatically positioned to compensate for differential thrust with minimal input required from the pilot. If a one engine inoperative missed approach is required, leave the autopilot engaged if it was previously engaged.

- The PF will press either TO/GA switch and call "MINIMUMS, GOING AROUND, FLAPS 5, CHECK POWER." The autothrottle of the operative engine will automatically advance up to full GA power as required in order to maintain approximately 2000 fpm rate of climb. If a manually flown missed approach is required, press either TO/GA switch, apply full go-around thrust and rotate towards 15 degrees pitch attitude. The FD commands a pitch attitude that will maintain the selected speed (final approach speed). With an engine inoperative, the resulting vertical speed will depend on temperature, available thrust and aircraft gross weight. The TO/GA roll mode maintains the existing ground track when TO/GA is selected.

- After a positive climb is indicated the PF will call “POSITIVE RATE, GEAR UP, CHECK MISSED APPROACH ALTITUDE.” Adjust the pitch attitude to maintain target speed (the $V_{REF} 20 + 5$ is approximately V_2 for flaps 5 and should be considered a minimum speed). Accomplish the missed approach procedure as illustrated at flaps 5.
- At 400 feet AFE (or after the check missed approach altitude call if the aircraft did not descend below 400 feet AFE), the PF will call “LNAV or HEADING SELECT” as appropriate in order to comply with the missed approach procedure or ATC instructions. If special engine out departure procedures are not a factor, consideration should be given to requesting a straight ahead missed approach. Selection of other pitch and roll modes below 400 feet AGL will not change the autopilot and flight director go-around modes.
- At 800 feet AFE or special obstacle clearance altitude (whichever is higher), the PF will call “CHECK TOP BUG” and accelerate to the appropriate speed and retract the flaps on schedule.

Upon reaching maneuvering speed for the desired flap setting the crew should consider the following prior to completing any checklists:

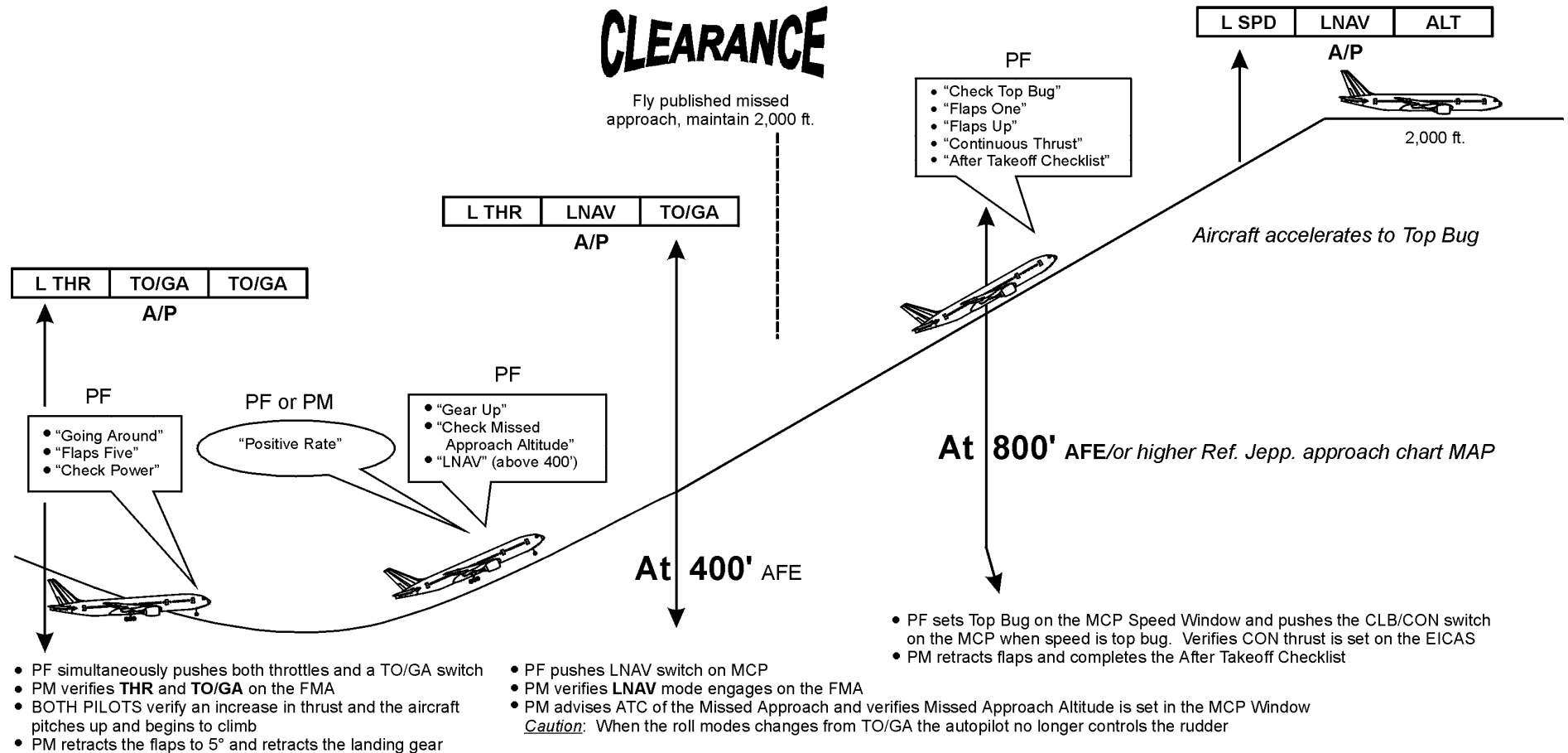
- Terrain
- Weather
- Crew workload management
- Diversion
- Use of the autopilot to reduce workload (autopilot may be engaged as soon as the aircraft is in trim at the maneuvering speed for the desired flap setting and the altitude is greater than 1000’ above field elevation).

One Engine Inoperative Missed Approach (TAC Inoperative)

With the TAC inoperative, but the autopilot engaged, yaw will be initially controlled by the autopilots. However, be prepared to immediately apply a rudder input when selecting another lateral mode, vertical mode or when altitude capture occurs. The system will revert to normal autopilot operation and automatic control of rudder will be discontinued.

With the TAC inoperative and a manually flown one engine inoperative missed approach the pilot must manually control the yaw with rudder and trim.

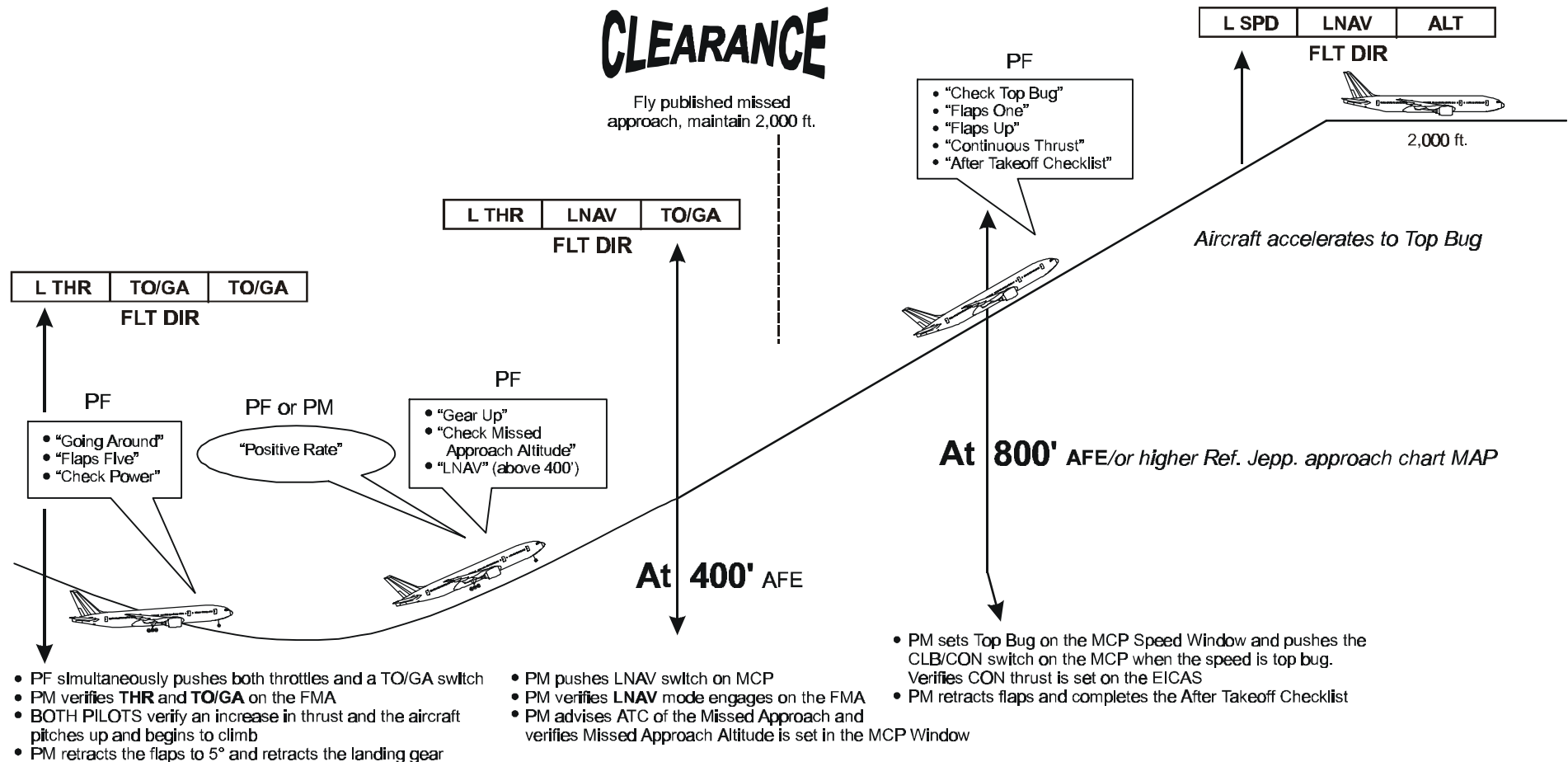
Engine Inoperative Coupled Go Around, Missed Approach Profile (LNAV)



Notes:

1. Go-Around speed is MCP target speed, current speed or target speed + 25 Kts. Maximum.
2. Pushing a TO/GA switch again will increase thrust limit to GA and ATS **THR REF** mode will be on the FMA.
3. At 400 ft. PF may push **HDG SEL/TRK SEL** on the MCP if a straight out missed approach is desired.
4. If the Missed Approach Altitude is captured prior to setting top bug, thrust will increase to the **GA** limit and the commanded speed is 5 Kts. below the selected flap placard speed, then Top Bug when the flaps retract.
5. PF may elect to say ("Check Flaps Five Speed" or "Check Flaps One Speed") and leave the flaps at 5° or retract them to 1° if returning for another approach. Select the CLB/CON switch on the MCP when the speed is at the Flaps 5°/1° maneuvering speed (or call "Continuous Power") PM will push the CLB/CON switch on the MCP.

Engine Inoperative Manual Go Around, Missed Approach Profile (LNAV)



Notes:

1. Go-Around speed is MCP target speed, current speed or target speed + 25 Kts. Maximum.
2. Pushing a TO/GA switch again will increase thrust limit to GA and ATS THR REF mode will be on the FMA.
3. At 400 ft. PF may push HDG SEL/TRK SEL on the MCP if a straight out missed approach is desired.
4. If the Missed Approach Altitude is captured prior to setting top bug, thrust will increase to the GA limit and the commanded speed is 5 Kts. below the selected flap placard speed, then Top Bug when the flaps retract.
5. PF may elect to say ("Check Flaps Five Speed" or "Check Flaps One Speed") and leave the flaps at 5° or retract them to 1° if returning for another approach. Select the CLB/CON switch on the MCP when the speed is at the Flaps 5°/1° maneuvering speed (or call "Continuous Power") PM will push the CLB/CON switch on the MCP.

Engine Failure on Final Approach

If an engine failure should occur on final approach with the flaps in the landing position, adequate thrust is available to maintain the approach profile using landing flaps, if desired.

A landing using flaps 30 might be preferable in some circumstances, especially if the failure occurs on short final or landing on runways where stopping distance is critical.

The ability to continue the approach with such a failure in CAT III operations may also be a factor. If the approach is continued at flaps 30, advance the thrust to maintain the appropriate airspeed.

If a go-around is required while at flaps 30, follow the normal go-around procedures, retracting the flaps to 20. Adequate performance is available at flaps 20. Subsequent flap retraction should be made at a safe altitude in level flight or a shallow climb.

Caution: If the decision is made not to continue the approach at flaps 30, execute a go-around as described above. Do not attempt to reconfigure the aircraft and continue the approach with flaps 20. The high power required to compensate for the power loss and the sink induced by flap retraction to 20 degrees will lead to an unstable condition.

☐ **ENG FUEL FILTER L, R**

Condition: An impending fuel filter bypass condition exists on the affected engine.

Note: Erratic engine operation and flameout may occur due to fuel contamination.

* * * *

☐ **ENG FUEL VALVE L, R**

Condition: Engine fuel or spar valve position disagrees with commanded position.

IF **ENG FUEL VALVE** message is displayed when the fuel control switch is positioned to CUTOFF, the engine may continue to run for approximately 10 seconds.

IF On the ground:

Do not attempt engine start.

Prevents possibility of not being able to shut down the engine if both valves subsequently fail open.

* * * *

ENG IDLE DISAGREE

Condition: One engine is at approach idle and the other engine is at minimum idle.

* * * *

☐ **ENG LIMIT PROT L, R**

Condition: Engine control is operating in alternate mode and commanded N_1 exceeds maximum N_1 .

Thrust Lever RETARD

Retard until N_1 remains within appropriate limits.

* * * *

☐ **ENG OIL FILTER L, R**

Condition: Affected engine oil filter contamination has caused filter bypass.

Autothrottle Arm Switch OFF

Allows thrust lever to remain where manually positioned.

Thrust Lever RETARD

Retard slowly until **ENG OIL FILTER** message is no longer displayed or the thrust lever is closed.

Decreases oil pressure in an attempt to stop filter bypass.

Ground Proximity Flap Override Switch OVRD

Note: Use flaps 20 and V_{REF} 20 for landing and flaps 5 for go-around.

IF ENG OIL FILTER Message Remains Displayed:

Fuel Control Switch CUTOFF

APU Selector (If APU Available) START, RELEASE TO ON

Provides an additional source of electrical power.

Transponder Mode Selector TA ONLY

Prevents climb commands which can exceed single engine performance capability.

Plan to land at the nearest suitable airport.

Ground Proximity Flap Override Switch OVRD

Note: Use flaps 20 and V_{REF} 20 for landing and flaps 5 for go-around.

* * * *



Condition: Engine oil pressure is low.

Autothrottle Arm Switch..... OFF

Allows thrust lever to remain where manually positioned.

Thrust Lever CLOSE

Stabilizes air flow through engine.

Fuel Control Switch..... CUTOFF

APU Selector (If APU Available) START, RELEASE TO ON

Provides an additional source of electrical power.

Transponder Mode Selector..... TA ONLY

Prevents climb commands which can exceed single engine performance capability.

Plan to land at the nearest suitable airport.

Ground Proximity Flap Override Switch..... OVRD

Note: Use flaps 20 and V_{REF} 20 for landing and flaps 5 for go-around.

* * * *

<input type="checkbox"/> ENG OIL TEMP L, R

Condition: Engine oil temperature is high.

Autothrottle Arm Switch..... OFF

Allows thrust lever to remain where manually positioned.

Thrust LeverMOVE TO MID POSITION

Allows oil to cool.

Ground Proximity Flap Override Switch..... OVRD

Note: Use flaps 20 and V_{REF} 20 for landing and flaps 5 for go-around.

IF Oil Temperature Above Red Line Limit, Or In Amber Band For 15 Minutes:

Thrust LeverCLOSE

Fuel Control Switch.....CUTOFF

APU Selector (If APU Available)START, RELEASE TO ON

Provides an additional source of electrical power.

Transponder Mode Selector.....TA ONLY

Prevents climb commands which can exceed single engine performance capability.

Plan to land at the nearest suitable airport.

Ground Proximity Flap Override Switch..... OVRD

Note: Use flaps 20 and V_{REF} 20 for landing and flaps 5 for go-around.

* * * *

ENG REV LIMITED L, R

Condition: Engine thrust reverser will not deploy or reverse thrust will be limited to idle on landing.

* * * *

ENG REVERSER L, R

Condition: Fault is detected in the affected engine reverser system.

* * * *

ENG RPM LIMITED L, R

Condition: Engine control is limiting affected engine thrust to prevent N_1 or N_2 from exceeding the RPM operating limit.

* * * *

ENG SHUTDOWN

Condition: Both engines were shutdown on the ground by the FUEL CONTROL switches or FIRE switches.

* * * *

ENG SHUTDOWN L, R

Condition: Engine was shutdown by the FUEL CONTROL switch or FIRE switch.

* * * *

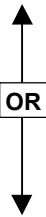
☐ **ENG START VALVE L, R**

Condition: Engine start valve is not in commanded position.

Ground or in-flight start using a bleed air source may be unsuccessful.

Bleed air is not available to the starter.

IF On The Ground:


Fuel Control Switch **CUTOFF**
Start/Ignition Selector **NORM**
 Prevents bleed air from entering starter if valve subsequently opens.

* * * *

IF In Flight:

Start/Ignition Selector **NORM**
 Prevents bleed air from entering starter if valve subsequently opens.
 Increase airspeed until X-BLD is no longer displayed.
 Assures sufficient air flow for windmill start.

* * * *

<input type="checkbox"/> ENG STARTER CUTOUT L, R

Condition: Start/ignition selector remains in START or engine start valve is open when commanded closed.

Start/Ignition Selector..... NORM

IF ENG STARTER CUTOUT Message Remains Displayed:

Engine Bleed Switch..... OFF

Removes bleed air source from starter.

Bleed Isolation Switch (Affected Side)..... OFF

Removes bleed air source from starter.

IF On The Ground:

Ground Air Source (If In Use)..... DISCONNECT

Removes bleed air source from starter.

Wing Anti-Ice Selector..... OFF

From bleed lose wing checklist prevents possible asymmetrical ice build up on the wings.

Do not accomplish the following checklists:

BLEED LOSS WING
PACK

* * * *

ENG THRUST L, R

Condition: Engine is not producing commanded thrust.

* * * *

☐ **FIRE APU**

Condition: Fire is detected in the APU.

APU Fire Switch PULL AND ROTATE

Rotate to the stop and hold for 1 second.

Shuts off combustibles, shuts down the APU, and discharges the fire extinguisher bottle.

Do not accomplish the following checklist:

APU SHUTDOWN

* * * *

☐ **FIRE ENG L, R**

Condition: Fire is detected in the engine.

Autothrottle Arm Switch..... OFF

Allows thrust lever to remain where manually positioned.

Thrust Lever CLOSE

Assists in recognition of affected engine.

Fuel Control Switch..... CUTOFF

Engine Fire Switch..... PULL

Shuts off fuel and hydraulic fluid and arms the fire extinguishing system.

IF FIRE ENG Message Remains Displayed:

Engine Fire Switch ROTATE

Rotate to the stop and hold for 1 second.

IF After 30 Seconds, **FIRE ENG** Message Remains Displayed:

Engine Fire SwitchROTATE TO OTHER BOTTLE

Rotate to the stop and hold for 1 second.

APU Selector (If APU Available).....START, RELEASE TO ON

Provides an additional source of electrical power.

Transponder Mode Selector TA ONLY

Prevents climb commands which can exceed single engine performance capability.

Plan to land at the nearest suitable airport.

Ground Proximity Flap Override Switch OVRD

Note: Use flaps 20 and V_{REF} 20 for landing and flaps 5 for go-around.

* * * *

2.8 - FIRE PROTECTION**TABLE OF CONTENTS**

BOTTLE 1, 2 DISCH ENG	1
BOTTLE DISCH APU.....	1
BOTTLE DISCH CARGO	1
<input type="checkbox"/> DET FIRE APU	1
DET FIRE CARGO AFT, FWD	2
DET FIRE ENG L, R.....	2
<input type="checkbox"/> FIRE APU	2
<input type="checkbox"/> FIRE CARGO AFT	3
<input type="checkbox"/> FIRE CARGO FWD.....	4
<input type="checkbox"/> FIRE ENG L, R	5
<input type="checkbox"/> FIRE WHEEL WELL	6
<input type="checkbox"/> OVERHEAT ENG L, R.....	7
SMOKE CREW REST F/D.....	8
<input type="checkbox"/> SMOKE LAVATORY	8
SMOKE LAVATORY	8

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BOTTLE 1, 2 DISCH ENG

Condition: Engine fire extinguisher bottle 1 or bottle 2 pressure is low.

* * * *

BOTTLE DISCH APU

Condition: APU fire extinguisher bottle pressure is low.

* * * *

BOTTLE DISCH CARGO

Condition: Both rapid discharge cargo fire extinguisher bottle pressures are low.

* * * *

☐ **DET FIRE APU**

Condition: APU fire detection is inoperative.

IF APU Not Running:

Do not start the APU unless use is required.

OR

* * * *

IF APU Running:

Plan to shut down the APU as soon as practical.

* * * *

DET FIRE CARGO AFT, FWD

Condition: Affected cargo compartment smoke detection is inoperative.

* * * *

DET FIRE ENG L, R

Condition: Affected engine fire detection is inoperative.

* * * *

☐ **FIRE APU**

Condition: Fire is detected in the APU.

APU Fire Switch.....PULL AND ROTATE

Rotate to the stop and hold for 1 second.

Shuts off combustibles, shuts down the APU, and discharges the fire extinguisher bottle.

Do not accomplish the following checklist:

APU SHUTDOWN

* * * *

**FIRE CARGO AFT**

Condition: Smoke is detected in the aft cargo compartment.

Aft Cargo Fire Arm Switch.....ARMED

Cargo Fire Discharge SwitchPUSH

Push and hold for 1 second.

Landing Altitude Selector.....PULL, SET 8000

Minimizes extinguisher agent leakage out of the compartment.

Plan to land at the nearest suitable airport.

Do not accomplish the following checklist:

LANDING ALTITUDE

- - - - WHEN AT TOP OF DESCENT - - - -

Landing Altitude Selector.....PUSH

Restores automatic selection of the FMC landing altitude.

* * * *



FIRE CARGO FWD

Condition: Smoke is detected in the forward cargo compartment.

Forward Cargo Fire Arm SwitchARMED

Cargo Fire Discharge SwitchPUSH

Push and hold for 1 second.

Landing Altitude Selector.....PULL, SET 8000

Minimizes extinguisher agent leakage out of the compartment.

Plan to land at the nearest suitable airport.

Note: Equipment cooling normal mode is inoperative. After 30 minutes of operation at low altitude and low cabin differential pressure, electronic equipment and displays may fail.

Do not accomplish the following checklists:

LANDING ALTITUDE
EQUIP COOLING OVRD

- - - - WHEN AT TOP OF DESCENT - - - -

Landing Altitude Selector.....PUSH

Restores automatic selection of the FMC landing altitude.

* * * *

☐ FIRE ENG L, R

Condition: Fire is detected in the engine.

Autothrottle Arm Switch **OFF**

Allows thrust lever to remain where manually positioned.

Thrust Lever **CLOSE**

Assists in recognition of affected engine.

Fuel Control Switch **CUTOFF**

Engine Fire Switch **PULL**

Shuts off fuel and hydraulic fluid and arms the fire extinguishing system.

IF FIRE ENG Message Remains Displayed:

Engine Fire Switch **ROTATE**

Rotate to the stop and hold for 1 second.

IF After 30 Seconds, **FIRE ENG** Message Remains Displayed:

Engine Fire Switch **ROTATE TO OTHER BOTTLE**

Rotate to the stop and hold for 1 second.

APU Selector (If APU Available) **START, RELEASE TO ON**

Provides an additional source of electrical power.

Transponder Mode Selector **TA ONLY**

Prevents climb commands which can exceed single engine performance capability.

Plan to land at the nearest suitable airport.

Ground Proximity Flap Override Switch **OVRD**

Note: Use flaps 20 and V_{REF} 20 for landing and flaps 5 for go-around.

* * * *

<input type="checkbox"/> FIRE WHEEL WELL

Condition: Fire is detected in a main wheel well. No fire extinguishing equipment is installed in the wheel wells. The primary source of overheats or fire is in the wheel brake system. Tests have shown that hot brakes alone will not cause a fire warning. A wheel well fire warning must be assumed to be an actual fire. If a warning should occur, the wheels should be extended removing the fire from the wheel wells.

Observe Gear Extend Limit Speed (270K/.82M)

Landing Gear Lever.....DN

Attempts to remove and extinguish the fire source.

Plan to land at the nearest suitable airport.

Note: Flight with gear down increases fuel consumption and decreases climb performance.

IF Landing Gear Must Be Retracted For Aircraft Performance:

When **FIRE WHEEL WELL** message no longer displayed:

Wait 20 minutes.

Attempts to ensure that wheel well fire is extinguished.

Landing Gear Lever..... UP

* * * *

☐ **OVERHEAT ENG L, R**

Condition: Overheat is detected in the nacelle.

Engine Bleed Switch OFF

Attempts to stop the flow of bleed air through the leak.

Autothrottle Arm Switch OFF

Allows thrust lever to remain where manually positioned.

Thrust Lever RETARD

Retard slowly until **OVERHEAT ENG** message is no longer displayed or the thrust lever is closed.

Reduces temperature in the nacelle.

IF **OVERHEAT ENG** Message No Longer Displayed:



OR



IF **OVERHEAT ENG** Message Remains Displayed:

Fuel Control Switch CUTOFF

APU Selector (If APU Available) START, RELEASE TO ON

Provides an additional source of electrical power.

Transponder Mode Selector TA ONLY

Prevents climb commands which can exceed single engine performance capability.

Plan to land at the nearest suitable airport.

Ground Proximity Flap Override Switch OVRD

Note: Use flaps 20 and V_{REF} 20 for landing and flaps 5 for go-around.

* * * *

SMOKE CREW REST F/D

Condition: Smoke is detected in flight deck crew rest compartment.

* * * *

**SMOKE LAVATORY**

Condition: Smoke is detected in one or more lavatories.

* * * *

SMOKE LAVATORY PROCEDURE

In the event of an alarm:

1. Treat all lavatory smoke alarm activations as possible fires.
2. One Flight Attendant will contact the Captain and advise him of the location of the alarm.
3. Another Flight Attendant will obtain a fire extinguisher, locate the correct lavatory, and conduct a visual inspection. If a fire exists, the Flight Attendant will attempt to extinguish it.
4. If the visual inspection reveals smoke and/or fire cannot be contained or extinguished, the Captain will be notified immediately. He will determine the nearest suitable airfield in case the source of the smoke cannot be contained and an emergency landing becomes necessary.
5. If the source of the smoke and/or fire cannot be contained or extinguished, the Captain will be notified, and emergency declared, and a landing at the nearest suitable airfield will be made. An emergency evacuation will be accomplished at the Captain's discretion.

If no smoke and/or fire is found and the chime continues to sound, a false activation should be suspected.

2.9 - FLT CONTROLS**TABLE OF CONTENTS**

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<input type="checkbox"/> FLAPS DRIVE	1
<input type="checkbox"/> FLAPS PRIMARY FAIL	2
<input type="checkbox"/> FLAP/SLAT CONTROL	2
<input type="checkbox"/> FLIGHT CONTROL MODE.....	3
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<input type="checkbox"/> THRUST ASYM COMP	10

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☐ **AUTO SPEEDBRAKE**

Condition: A fault is detected in the automatic speedbrake system.

Note: Do not arm speedbrake lever.

Prevents inadvertent in-flight extension.

Note: Manually extend speedbrakes after landing.

* * * *

☐ **FLAPS DRIVE**

Condition: Flap drive mechanism has failed.

Do not use alternate flaps.

Asymmetry and uncommanded motion protection is not provided in alternate mode.

Ground proximity Flap Override Switch OVRD

Note: Do not use FMC fuel predictions with flaps extended.

IF Flap Position UP Or 1:

Position flap lever to 1 and use $V_{REF}30 + 40$ for landing.

OR

* * * *

IF Flap Position Between 1 And 5 Or At 5:

Use current flaps and $V_{REF}30 + 40$ for landing.

OR

* * * *

IF Flap Position Between 5 And 20:

Use current flaps and $V_{REF}30 + 20$ for landing.

OR

* * * *

IF Flap Position 20 Or Greater:

Use current flaps and $V_{REF}20$ for landing.

Do not accomplish the following checklist:

FLAPS PRIMARY FAIL

* * * *

☐ **FLAPS PRIMARY FAIL**

Condition: Flaps are operating in secondary mode.

Ground Proximity Flap Override Switch.....OVRD

Note: Plan additional time for slower flap operation.

Note: Use flaps 20 and V_{REF} 20 for landing.

Provides improved go-around performance.

* * * *

☐ **FLAP/SLAT CONTROL**

Condition: Flap/slat electronics units are inoperative.

IF Flap Retraction Required:

Flap LeverUP

Alternate Flaps Arm Switch ALTN

Alternate Flaps Selector.....RET

Monitor airspeed during retraction.

Ground Proximity Flap Override Switch.....OVRD

Note: Plan additional time for alternate slat and flap extension. Flap operation is slower in alternate mode.

Note: Due to flap/slat electronics units failure select ITEM OVRD for FLAPS action line on LANDING checklist.

Note: Use flaps 20 and V_{REF} 20 for landing.

Alternate mode is limited to a maximum of flaps 20.

◀ ◀ ◀ ◀ ◀ **DEFERRED ITEMS** ▶ ▶ ▶ ▶ ▶

==> APPROACH CHECKLIST

Alternate Flaps Arm Switch..... ALTN

Alternate Flaps Selector EXT

Monitor airspeed during extension.

Extends flaps to flaps 20 position.

* * * *

☐ **FLIGHT CONTROL MODE**

Condition: Flight control system is operating in secondary mode.

Primary Flight Computers

Disconnect SwitchDISC, THEN AUTO

Attempts to restore flight control normal mode.

IF **FLIGHT CONTROL MODE** Message Remains Displayed:

Avoid abrupt control inputs.

Aircraft response is changed by simplified elevator feel and rudder ratio systems.

Ground Proximity Flap Override Switch.....OVRD

Note: Inoperative items:

- Envelope protection functions
- Autopilot.

Note: Yaw dampening is degraded.

Note: Manual control inputs are required to compensate for asymmetric thrust conditions.

Note: Use flaps 20 and V_{REF20} for landing. Ensures sufficient pitch trim capability for landing.

Note: Do not arm speedbrake lever.

Note: Manually extend speedbrakes after landing.

Do not accomplish the following checklists:

AUTO SPEEDBRAKE
THRUST ASYM COMP

* * * *

☐ FLIGHT CONTROLS

Condition: Multiple flight control surfaces are inoperative or other flight control system faults are detected.

Handling qualities are degraded.

Pitch and roll control capability is reduced with fewer operating control surfaces.

Plan to land at the nearest suitable airport.

Ground Proximity Flap Override Switch.....OVRD

Note: Use flaps 20 and $V_{REF}30 + 20$ for landing.

Higher approach speeds improve aircraft maneuvering characteristics.

Note: Crosswind limit for landing is 20 knots. Less control authority decreases crosswind landing capability.

Note: Roll rate may be reduced inflight. Speedbrake effectiveness may be reduced inflight and during landing.

Do not accomplish the following checklist:

SPOILERS

* * * *

FLT CONTROL VALVE

Condition: One or more flight control valves remain closed when commanded open or one or more flight control shutoff switches are in SHUTOFF.

* * * *

☐ **PITCH DOWN AUTHORITY**

Condition: Pitch down authority is limited.

Slower airspeeds assist nose down pitch control.

Aircraft is approaching its nose down pitch control limit.

Note: Avoid speedbrake use and rapid thrust increases.

Only limited elevator authority is available to counter nose up pitching.

* * * *

☐ **PITCH UP AUTHORITY**

Condition: Pitch up and flare authority are limited.

Do not extend flaps any further until on approach.

Aircraft is approaching its nose up pitch control limit.

Ground Proximity Flap Override Switch..... OVRD

Note: Do not use Autoland.

IF Flap Position 15 Or Less:

Note: Use flaps 5 and $V_{REF}30 + 40$ for landing.

Higher approach speeds provide better pitch up control authority.

OR

* * * *

IF Flap Position 20 Or Greater:

Note: Use flaps 20 and $V_{REF}30 + 20$ for landing.

Higher approach speeds provide better pitch up control authority.

* * * *

☐ **PRI FLIGHT COMPUTERS**

Condition: Flight control system is operating in direct mode.

Primary Flight Computers

Disconnect SwitchDISC, THEN AUTO

Attempts to restore flight control normal mode.

IF PRI FLIGHT COMPUTERS Message Remains Displayed:

Avoid abrupt control inputs.

Aircraft response is changed by simplified elevator feel and rudder ratio systems.

Ground Proximity Flap Override SwitchOVRD

Note: Inoperative items:

- Envelope protection functions
- Autopilot
- Yaw damping
- Rudder manual trim cancel switch.

Note: Manual control inputs are required to compensate for asymmetric thrust conditions.

Note: Use flaps 20 and V_{REF20} for landing. Ensures sufficient pitch trim capability for landing.

Note: Do not arm speedbrake lever. Prevents inadvertent inflight extension.

Note: Manually extend speedbrakes after landing.

Do not accomplish the following checklists:

AUTO SPEEDBRAKE
THRUST ASYM COMP

* * * *

☐ **SLATS DRIVE**

Condition: Slat drive mechanism has failed.

Do not use alternate flaps.

Asymmetry and uncommanded motion protection are not provided in alternate mode.

Ground Proximity Flap Override Switch.....OVRD

Note: Do not use FMC fuel prediction with slats extended.

Note: Do not use AUTOLAND.

Note: Use flaps 20 and $V_{REF}30 + 30$ for landing.

Provides better handling qualities when slats are not fully extended.

Do not accomplish the following checklist:

SLATS PRIMARY FAIL

* * * *

☐ **SLATS PRIMARY FAIL**

Condition: Slats are operating in secondary mode.

Note: Plan additional time for slower slat operation.

Note: Slats will extend beyond midrange when airspeed is below 239 knots. For go-around, do not exceed 239 knots until slats retract to midrange.

* * * *

SPEEDBRAKE EXTENDED

Condition: Speedbrake is extended when radio altitude is between 15 and 800 feet, or when the flap lever is in a landing position, or when either thrust lever is not closed.

* * * *

☐ **SPOILERS**

Condition: One or more spoiler pairs are inoperative.

Note: Roll rate may be reduced in flight. Speedbrake effectiveness may be reduced in flight and during landing.

* * * *

☐ **STAB GREENBAND**

Condition: Nose gear pressure switch disagrees with computed stabilizer greenband.

FMC Weight And CG Entries.....CHECK

An incorrect entry may cause an incorrect stab greenband calculation.

* * * *

☐ **STABILIZER**

Condition: Uncommanded stabilizer **motion is detected or stabilizer is inoperative.**

Stabilizer Cutout Switch..... CUTOUT

Prevents subsequent uncommanded or inappropriate stabilizer motion.

Do not exceed current airspeed.

Nose down elevator authority is limited.

Stabilizer is inoperative. Pitch trim remains available in the normal flight control mode.

Ground Proximity Flap Override Switch.....OVRD

Note: Use flaps 20 and $V_{REF}30 + 20$ for landing.

Provides sufficient elevator authority for landing.

Do not accomplish the following checklist:

FLIGHT CONTROLS

* * * *

☐ **STABILIZER C**

Condition: Center stabilizer control path is inoperative.

Center Stabilizer Cutout Switch..... CUTOUT

Prevents subsequent uncommanded or inappropriate stabilizer motion.

Note: Left control wheel pitch trim switches may be inoperative.

* * * *

STABILIZER CUTOUT

Condition: Both stabilizer cutout switches are in CUTOUT.

* * * *

☐ **STABILIZER R**

Condition: Right stabilizer control path is inoperative.

Right Stabilizer Cutout Switch..... CUTOUT

Prevents subsequent uncommanded or inappropriate stabilizer motion.

Note: Right control wheel pitch trim switches may be inoperative.

* * * *

☐ **THRUST ASYM COMP**

Condition: Thrust asymmetry compensation is inoperative.

Thrust Asymmetry Compensation Switch..... OFF THEN AUTO

IF THRUST AYM COMP Message Remains Displayed:

Note: Manual control inputs are required to compensate for asymmetric thrust conditions.

* * * *

2.10 - FLT INSTM DSP**TABLE OF CONTENTS**

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BARO SET DISAGREE	1
DISPLAY SELECT PNL.....	1
<input type="checkbox"/> EFIS CONTROL PNL L, R.....	1
SGL SOURCE AIR DATA.....	1
<input type="checkbox"/> SGL SOURCE DISPLAYS.....	2
SGL SOURCE RAD ALT	2
SINGLE SOURCE F/D	2

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☐ **ALTN ATTITUDE**

Condition: Both AIR DATA/ATTITUDE source switches are in the ALTN position.

Note: Both PFDs and the standby attitude indicator are displaying SAARU attitude information.

* * * *

BARO SET DISAGREE

Condition: Captain and First Officer's barometric settings disagree.

* * * *

DISPLAY SELECT PNL

Condition: Left, center, or right CDU control of the display select panel is active.

* * * *

☐ **EFIS CONTROL PNL L, R**

Condition: EFIS control panel is inoperative or CDU control of the EFIS control panel is active.

Note: CDU control of the EFIS control panel is accessed from the CDU menu page.

* * * *

SGL SOURCE AIR DATA

Condition: Both PFDs are receiving air data from the same single channel source.

* * * *

☐ **SGL SOURCE DISPLAYS**

Condition: Some or all display units are using a single source of display information.

Note: Both PFDs and NDs or just both NDs are displaying information generated from a single source. Lower center display unit may be blank or may not be capable of displaying all normal formats. Left EFIS control panel controls either right PFD and ND or right ND only.

* * * *

SGL SOURCE RAD ALT

Condition: Both PFDs are using the same source for radio altimeter information.

* * * *

SINGLE SOURCE F/D

Condition: Both PFDs are using the same source for flight director information.

* * * *

2.11 - FLT MGT NAV
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<input type="checkbox"/> FMC	1
FMC MESSAGE.....	1
GPS.....	2
<input type="checkbox"/> ILS ANTENNA.....	2
<input type="checkbox"/> NAV ADIRU INERTIAL	3
<input type="checkbox"/> NAV AIR DATA SYS	5
<input type="checkbox"/> NAV UNABLE RNP	7
SINGLE SOURCE ILS	7
TRANSPONDER L, R.....	7

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☐ **FMC**

Condition: Both FMC's have failed or FMC selector is in L with left FMC failed or in R with right FMC failed.

Select autopilot roll and pitch modes appropriate for the desired flight path.

LNAV and VNAV modes fail and VNAV guidance is lost when both FMC's fail.

Note: LNAV can be re-engaged. Plan to enter new waypoints by latitude and longitude into any CDU.

Note: Manually tune navigation radios through the CDU's.

Note: Refer to the Performance Section 5 for V_{REF} speed and other applicable performance information.

Landing Altitude Selector..... PULL, SET MANUALLY

Do not accomplish the following checklist:

LANDING ALTITUDE

* * * *

FMC MESSAGE

Condition: A message is in the FMC scratch pad.

* * * *

GPS

Condition: GPS has failed.

* * * *

☐ **ILS ANTENNA**

Condition: Two or more ILS receivers are not using the correct antennas for best reception.

Note: AFDS may have difficulty capturing and/or tracking localizer and/or glideslope. Aircraft path may be lower than indicated by glideslope pointer.

* * * *

☐ **NAV ADIRU INERTIAL**

Condition: ADIRU is not capable of providing valid attitude, position, heading, track, and ground speed.

Heading information is displayed for 3 minutes after the **NAV ADIRU INERTIAL** message is displayed. If the aircraft is in the polar region, heading information is removed immediately.

GPS continues to provide position and track information.

Transponder Altitude Source SelectorALTN

Selects SAARU as air data source for transponder altitude reporting in case the **NAV ADIRU INERTIAL** message was due to a complete failure of the ADIRU.

Note: Inoperative items:

- FMC VNAV pages
- FMC performance predictions
- PFD flap maneuvering speeds; refer to V_{REF} and Flap Maneuver Speed Tables in Performance Section 5
- ND wind direction/speed and wind arrow
- Autobrake

Note: Inoperative AFDS modes:

- LNAV
- VNAV
- TO/GA
- LOC
- GS
- FPA
- TRK HOLD/SEL.

(Continued)

When heading no longer displayed and SET HDG line displayed on POS INIT page 1/3:

HeadingENTER

Sets SAARU heading to proper reference for display.

Autopilot (If Required).....RE-ENGAGE

Note: Crosscheck heading periodically for drift with the magnetic compass and update SAARU heading as necessary. If magnetic compass information is unreliable or unavailable, track information may be used.

Note: VOR course deviation is available in the ND VOR mode. ILS localizer and glideslope deviation raw data is available on both the PFD and the ND.

Note: If GPS is unavailable, the following additional items are inoperative:

- ND map mode
- Active LEG course and distance
- Direct to waypoint function
- Alternate page DIVERT NOW function
- Navigation radio autotuning.

* * *

☐ NAV AIR DATA SYS

Condition: Information from air data sources is no longer being combined for display.

Avoid abrupt control inputs.

Aircraft response is changed by simplified elevator feel and rudder ratio systems.

Crosscheck airspeed and altitude on the PFDs and standby flight instruments for accuracy.

Each display is receiving data from an independent source.

Note: Normal pitch attitude and thrust settings are available in flight with unreliable airspeed table in Performance Section 5.

Note: Select alternate air data/attitude source if airspeed or altitude on the respective PFD is determined to be in error and the airspeed or altitude on the opposite side PFD is verified to be correct. Attempts to remove erroneous data from PFD.

Ground Proximity Flap Override SwitchOVRD

From FLIGHT CONTROL MODE checklist.

Note: Inoperative items:

- Envelope protection functions
- Autopilot
- Flight directors
- Autothrottles
- PFD flap maneuvering speeds; refer to V_{REF} and Flap Maneuver Speed Tables in Performance Section 5.

Inoperative items envelop protection functions and autopilot from FLIGHT CONTROL MODE checklist.

Note: Yaw damper is degraded. From FLIGHT CONTROL MODE checklist.

(Continued)

Note: Manual control inputs are required to compensate for asymmetric thrust conditions. From THRUST ASYM COMP checklist.

Note: Use flaps 20 and VREF20 for landing. From FLIGHT CONTROL MODE checklist. Ensures sufficient pitch control for landing.

Note: Do not arm speedbrake lever. From AUTO SPEEDBRAKE checklist. Prevents inadvertent inflight extension.

Note: Manually extend speedbrakes after landing. From AUTO SPEEDBRAKE checklist.

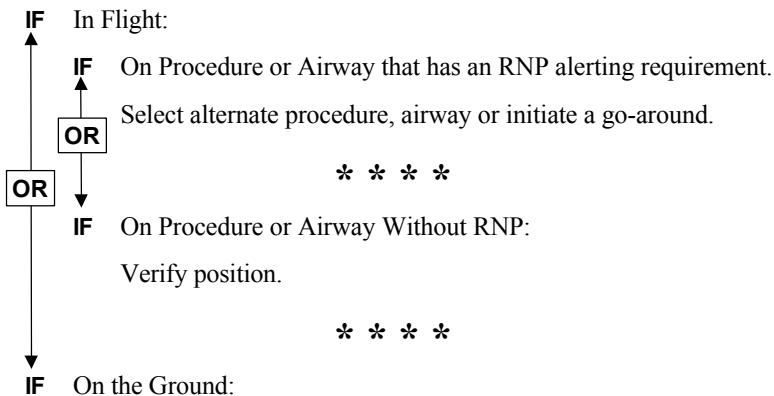
Do not accomplish the following checklists:

AUTO SPEEDBRAKE
FLIGHT CONTROL MODE
THRUST ASYM COMP

* * * *

☐ NAV UNABLE RNP

Condition: Navigation performance does not meet required accuracy.



Plan to park aircraft for 6 to 15 minutes until dash prompts appear on SET INERTIAL POS line and new aircraft position can be entered.

POS INIT Page **SELECT**

When dash prompts appear on SET INERTIAL POS line:

Position **ENTER**

Enter most accurate aircraft position.

Continue normal operations. There are no dispatch restrictions.

* * * *

SINGLE SOURCE ILS

Condition: Both PFDs and NDs are using the same source for ILS information.

* * * *

TRANSPONDER L, R

Condition: Affected transponder has failed.

* * * *

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2.12 - FUEL**TABLE OF CONTENTS**

<input type="checkbox"/> FUEL AUTO JETTISON	1
<input type="checkbox"/> FUEL CROSSFEED AFT	2
<input type="checkbox"/> FUEL CROSSFEED FWD	2
<input type="checkbox"/> FUEL IMBALANCE	3
FUEL IN CENTER	3
FUEL JETT NOZZLE L, R	3
<input type="checkbox"/> FUEL JETTISON MAIN	4
<input type="checkbox"/> FUEL JETTISON SYS	4
FUEL LOW CENTER	5
<input type="checkbox"/> FUEL PRESS ENG L, R	5
FUEL PRESS ENG L+R	5
<input type="checkbox"/> FUEL PUMP CENTER L, R	6
FUEL PUMP L AFT, FWD	6
FUEL PUMP R AFT, FWD	6
<input type="checkbox"/> FUEL QTY LOW	7
<input type="checkbox"/> FUEL TEMP LOW	7
<input type="checkbox"/> FUEL VALVE APU	8

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☐ **FUEL AUTO JETTISON**

Condition: Fuel jettison automatic shutoff has failed, or total fuel quantity is less than selected TO REMAIN quantity and a nozzle valve is open.

IF One Or More Tank Quantity Indications Blank:

Determine jettison time using the following rates:

- Fuel in center tank: 5400 lbs./minute
- Center tank empty: 3100 lbs./minute

Fuel Jettison Nozzle Switches..... ON

Do not accomplish the following checklist:

FUEL JETTISON

----- WHEN FUEL JETTISON COMPLETE -----

Fuel Jettison Nozzle Switches..... OFF

Closes fuel jettison nozzle valves.

Fuel Jettison Arm Switch OFF

Disarms fuel jettison system and removes FUEL TO REMAIN quantity from EICAS.

IF FUEL Line On PERF INIT Page Is Blank:

Wait 5 minutes after fuel jettison arm switch was positioned OFF.

Manual entry of fuel quantity is not possible until 5 minutes after jettison is complete.

Enter current estimated total fuel in the FUEL line box prompts on the PERF INIT page.

Provides gross weight data for FMC performance calculations and allows VNAV to be re-engaged.

* * * *

☐ FUEL CROSSFEED AFT

Condition: Aft crossfeed valve is not in the commanded position.

IF Aft Crossfeed Switch ON:

Forward Crossfeed Switch ON

Provides alternate path for fuel crossfeed.

* * * *

☐ FUEL CROSSFEED FWD

Condition: Forward crossfeed valve is not in the commanded position.

IF Forward Crossfeed Switch ON:

Aft Crossfeed Switch ON

Provides alternate path for fuel crossfeed.

* * * *

☐ **FUEL IMBALANCE**

Condition: Fuel imbalance between main tanks is excessive.

IF Fuel Leak Suspected:

↑
Accomplish the FUEL LEAK checklist.

OR

* * * *

↓
IF Fuel Leak Not Suspected:

Crossfeed Switch (Either)..... ON

Allows fuel from the high tank to feed both engines.

Forward And Aft

Fuel Pump Switches (Low tank) OFF

Allows fuel from the high tank to feed both engines.

----- WHEN FUEL BALANCING COMPLETE -----

Forward And Aft Fuel Pump Switches (All)..... ON

Restores fuel feed from low tank.

Crossfeed Switches OFF

Restores main tank-to-engine fuel feed.

* * * *

FUEL IN CENTER

Condition: Both center fuel pump switches are OFF with fuel in the center tank.

* * * *

FUEL JETT NOZZLE L, R

Condition: Jettison nozzle valve is not in the commanded position.

* * * *

☐ FUEL JETTISON MAIN

Condition: Fuel jettison from main tanks is inoperative.

Fuel jettison can occur only from the center tank.

Do not accomplish the following checklist:

FUEL JETTISON

When center tank empty or FUEL TO REMAIN quantity reached:

Fuel Jettison Nozzle Switches..... OFF

Fuel Jettison Arm Switch OFF

* * * *

☐ FUEL JETTISON SYS

Condition: Fuel jettison system is inoperative.

Fuel Jettison Nozzle Switches..... OFF

Closes fuel jettison nozzle valves.

Fuel Jettison Arm Switch OFF

Disarms fuel jettison system and removes TO REMAIN quantity from EICAS.

Do not accomplish the following checklist:

FUEL JETTISON

* * * *

FUEL LOW CENTER

Condition: Center tank is empty and one or both center fuel pump switches are ON.

* * * *

☐ **FUEL PRESS ENG L, R**

Condition: Engine is on suction feed.

Note: At high altitude thrust deterioration or engine flameout may occur.

IF Unable To Maintain Required Thrust On Affected Engine:

Crossfeed Switch (Either)..... ON

Allows fuel feed from operative pump side.

Note: Continued operation with a crossfeed valve open will result in a progressive fuel imbalance due to both engines feeding from the same main tank.

Do not balance fuel.

Do not accomplish the following checklist:

FUEL IMBALANCE

When **FUEL IMBALANCE** message displays:

Crossfeed Switches (Both) OFF

Continue suction feed operation. Sufficient roll control is available to compensate for any main tank fuel imbalance.

If unable to maintain required thrust on affected engine, operate at lower altitude.

* * * *

FUEL PRESS ENG L+R

Condition: All fuel pump output pressures are low.

* * * *

☐ **FUEL PUMP CENTER L, R**

Condition: Center fuel pump output pressure is low.

IF Either **FUEL PUMP CENTER L** Or **FUEL PUMP CENTER R** Message Displayed:



Crossfeed Switch (Either)..... ON

OR

Prevents fuel imbalance by feeding both engines from the same center fuel pump.



* * * *

IF Both **FUEL PUMP CENTER L** And **FUEL PUMP CENTER R** Messages Displayed:

Check available left and right main tank quantity is sufficient for the planned flight.

Center tank fuel is not available.

Crossfeed Switches OFF

Sets up main tank-to-engine fuel feed.

* * * *

FUEL PUMP L AFT, FWD

Condition: Left aft or forward fuel pump output pressure is low.

* * * *

FUEL PUMP R AFT, FWD

Condition: Right aft or forward fuel pump output pressure is low.

* * * *

☐ **FUEL QTY LOW**

Condition: Fuel quantity is low in either main tank.

IF Fuel Leak Suspected:

↑
Accomplish the FUEL LEAK checklist.

OR

* * * *

↓
IF Fuel Leak Not Suspected:

Crossfeed Switch (Either).....ON

Ensures fuel is available to both engines if the low tank empties.

Fuel Pump Switches (All).....ON

Ensures all fuel is available for use.

Plan to land at the nearest suitable airport.

Note: Avoid high nose up attitude and excessive acceleration to prevent forward pumps from uncovering.

Prevents forward pumps from uncovering.

* * * *

☐ **FUEL TEMP LOW**

Condition: Fuel temperature is approaching minimum.

Increase airspeed, change altitude, and/or deviate to a warmer air mass to achieve a TAT equal to or higher than the fuel temperature limit (3 degrees C above the fuel freeze point).

TAT increases approximately 0.5 to 0.7 degrees C for each 0.01 increase in airspeed. In extreme conditions it may be necessary to descend as low as FL 250.

* * * *

<input type="checkbox"/> FUEL VALVE APU
--

Condition: APU fuel valve is not in the commanded position.

Do not start the APU.

Prevents a potential fire hazard.

Note: APU is not available for remainder of flight.

Do not accomplish the following checklist:

APU SHUTDOWN

* * * *

2.13 - HYDRAULICS**TABLE OF CONTENTS**

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☐ **HYD AUTO CONTROL C**

Condition: Both center demand pump auto functions and all center hydraulic system indications are inoperative.

C1 Demand Pump Selector **ON**

Provides continuous demand pump pressure.

* * * *

☐ **HYD AUTO CONTROL L, R**

Condition: Demand pump auto function and all left or right hydraulic system indications are inoperative.

Demand Pump Selector (Affected System) **ON**

Provides continuous demand pump pressure.

* * * *

☐ **HYD OVERHEAT DEM C1, C2, L, R**

Condition: Demand pump temperature is high.

Demand Pump Selector **OFF**

Attempts to eliminate source of overheat.

Do not accomplish the following checklist:

HYD PRESS DEM

* * * *

☐ **HYD OVERHEAT PRI C1, C2**

Condition: Primary pump temperature is high.

Primary Pump Switch..... **OFF**

Attempts to eliminate source of overheat.

Do not accomplish the following checklist:

HYD PRESS PRI

* * * *

☐ **HYD OVERHEAT PRI L, R**

Condition: Primary pump temperature is high.

Primary Pump Switch..... **OFF**

Attempts to eliminate source of overheat.

Note: Thrust reverser on the affected side may be inoperative.

Do not accomplish the following checklist:

HYD PRESS PRI

* * * *

☐ **HYD PRESS DEM C1, C2, L, R**

Condition: Demand pump output pressure is low when commanded on.

Demand Pump Selector..... ON

Restores system pressure if auto demand function failed to operate.

IF HYD PRESS DEM Message Remains Displayed:

Demand Pump Selector..... OFF

Avoids system contamination and/or pump damage.

* * * *

☐ **HYD PRESS PRI C1, C2**

Condition: Primary pump output pressure is low.

Primary Pump Switch..... OFF

Avoids system contamination and/or damage.

* * * *

☐ **HYD PRESS PRI L, R**

Condition: Primary pump output pressure is low.

Primary Pump Switch..... OFF

Note: Thrust reverser on the affected side may be inoperative.

* * * *

☐ **HYD PRESS SYS C**

Condition: Center hydraulic system pressure is low.

C1 Or C2 Demand Pump Selector..... ON

Restores system pressure if auto demand function failed to operate.

IF HYD PRESS SYS C Message Remains Displayed:

C2 Primary Pump Switch OFF

Avoids system contamination and/or pump damage.

C1 And C2 Demand Pump Selectors OFF

Avoids system contamination and/or pump damage and prevents an air system low flow condition.

Ground Proximity Flap Override Switch.....OVRD

Note: Inoperative items:

- Main landing gear hydraulic operation
- Main gear steering.

Note: Plan additional time for slower slat and flap operation.

Note: Slats will extend beyond midrange when airspeed is below 239 knots. For go-around, do not exceed 239 knots until slats retract to midrange.

Note: Use flaps 20 and V_{REF20} for landing. Ensures adequate go-around performance due to slower slat/flap operation in secondary mode.

Note: Roll rate may be reduced inflight. Speedbrake effectiveness may be reduced inflight and during landing.

Note: Do not arm speedbrake lever. Prevents inadvertent inflight extension.

Note: Manually extend speedbrakes after landing.

Note: For go around, observe gear extend limit speed (270 kts/ .82 Mach).

(Continued)

Do not accomplish the following checklists:

AUTO SPEEDBRAKE
SPOILERS

◀ ◀ ◀ ◀ ◀ DEFERRED ITEMS ▶ ▶ ▶ ▶ ▶

==> APPROACH CHECKLIST

Initiate flap extension as required.

Landing Gear Lever..... DN

Ensures nose gear extension if pressure still exists in that part of the system.

Alternate Gear Switch.....DOWN

Push and hold for one second.

Reduction of airspeed to below 240 knots may be necessary for landing gear to lock down.

Do not accomplish the following checklists:

FLAPS PRIMARY FAIL
SLATS PRIMARY FAIL
GEAR DOOR

* * * *

☐ **HYD PRESS SYS L**

Condition: Left hydraulic system pressure is low.

Left Demand Pump Selector ON

Restores system pressure if auto demand function failed to operate.

IF **HYD PRESS SYS L** Message Remains Displayed:

Left Primary pump Switch OFF

Left Demand Pump Selector OFF

Avoids system contamination and/or pump damage.

Note: Inoperative items:

- Left Thrust Reverser
- Autoland

Note: Roll rate may be reduced in flight. Speedbrake effectiveness may be reduced inflight and landing.

Do not accomplish the following checklist:

SPOILERS

* * * *

☐ **HYD PRESS SYS L+C**

Condition: Left and center hydraulic system pressures are low.

Left Demand Pump Selector..... ON

Restores system pressure if auto demand function failed to operate.

C1 Or C2 Demand Pump Selector..... ON

Restores system pressure if auto demand function failed to operate.

IF HYD PRESS SYS L+C Message Remains Displayed:

Left Primary Pump Switch OFF

C2 Primary Pump Switch OFF

Avoids system contamination and/or pump damage.

Left Demand Pump Selector OFF

Avoids system contamination and/or pump damage.

C1 And C2 Demand Pump Selectors OFF

Avoids system contamination and/or pump damage and prevents an air system low flow condition.

Handling qualities are degraded.

Pitch and roll control capability is reduced with fewer operating control surfaces.

Plan to land at the nearest suitable airport.

Ground Proximity Flap Override Switch.....OVRD

Note: Inoperative items:

- Multiple flight control surfaces
- Autoland
- Main landing gear hydraulic operation
- Left thrust reverser
- Main gear steering.

(Continued)

IF HYD PRESS SYS L+C Message Remains Displayed: (Continued)

- Note: Plan additional time for slower slat and flap operation.
- Note: Slats will extend beyond midrange when airspeed is below 239 knots. For go-around, do not exceed 239 knots until slats retract to midrange.
- Note: Use flaps 20 and $V_{REF}30 + 20$ for landing. Higher approach speeds improve aircraft-maneuvering characteristics.
- Note: Crosswind limit for landing is 20 knots. Less control authority decreases crosswind-landing capability.
- Note: Roll rate may be reduced in flight. Speedbrake effectiveness may be reduced inflight and landing.
- Note: Do not arm speedbrake lever. Prevents inadvertent inflight extension.
- Note: Manually extend speedbrakes after landing.
- Note: For go around, observe gear extend limit speed (270 k/.82 Mach).

Do not accomplish the following checklists:

AUTO SPEEDBRAKE
FLIGHT CONTROLS
SPOILERS

◀ ◀ ◀ ◀ ◀ DEFERRED ITEMS ▶ ▶ ▶ ▶ ▶

==> APPROACH CHECKLIST

Initiate flap extension as required.

Landing Gear Lever DN

Ensures nose gear extension if pressure still exists in that part of the system.

(Continued)

Alternate Gear Switch.....DOWN

Push and hold for 1 second.

Reduction of airspeed to below 240 knots may be necessary for landing gear to lock down.

Do not accomplish the following checklists:

FLAPS PRIMARY FAIL

SLATS PRIMARY FAIL

GEAR DOOR

* * * *

HYD PRESS SYS L+C+R

Condition: All hydraulic system pressures are low.

* * * *

☐ HYD PRESS SYS L+R

Condition: Left and right hydraulic system pressures are low.

Left Demand Pump Selector..... ON

Restores system pressure if auto demand function failed to operate.

Right Demand Pump Selector..... ON

Restores system pressure if auto demand function failed to operate.

IF HYD PRESS SYS L+R Message Remains Displayed:

Left Primary Pump Switch OFF

Right Primary Pump Switch..... OFF

Left Demand Pump Selector OFF

Avoids system contamination and/or pump damage.

Right Demand Pump Selector..... OFF

Avoids system contamination and/or pump damage.

Handling qualities are degraded.

Pitch and roll control capability is reduced with fewer operating control surfaces.

Plan to land at the nearest suitable airport.

Ground Proximity Flap Override Switch.....OVRD

Note: Inoperative items:

- Multiple flight control surfaces
- Autoland
- Left and right thrust reverser's
- Autobrake
- Normal brakes.

Note: Use flaps 20 and $V_{REF}30 + 20$ for landing. Higher approach speeds improve aircraft-maneuvering characteristics.

(Continued)

Note: Crosswind limit for landing is 20 knots. Less control authority decreases crosswind-landing capability.

Note: Roll rate may be reduced inflight. Speedbrake effectiveness may be reduced inflight and during landing.

Do not accomplish the following checklists:

FLIGHT CONTROLS

SPOILERS

* * * *

☐ **HYD PRESS SYS R**

Condition: Right hydraulic system pressure is low.

Right Demand Pump Selector..... ON

Restores system pressure if auto demand function failed to operate.

IF HYD PRESS SYS R Message Remains Displayed:

Right Primary Pump Switch..... OFF

Right Demand Pump Selector..... OFF

Avoids system contamination and/or pump damage.

Note: Inoperative items:

- Right thrust reverser
- Autobrake
- Normal brakes.

Note: Roll rate may be reduced inflight. Speedbrake effectiveness may be reduced inflight and during landing.

Do not accomplish the following checklist:

SPOILERS

* * * *

<input type="checkbox"/> HYD PRESS SYS R+C

Condition: Right and center hydraulic system pressures are low.

C1 Or C2 Demand Pump Selector..... ON

Restores system pressure if auto demand function failed to operate.

Right Demand Pump Selector..... ON

Restores system pressure if auto demand function failed to operate.

IF HYD PRESS SYS R+C Message Remains Displayed:

Stabilizer Cutout Switches CUTOUT

Prevents display of **STABILIZER** message.

Do not exceed current airspeed.

Nose down elevator authority is limited.

C2 Primary Pump Switch OFF

Avoids system contamination and/or pump damage.

Right Primary Pump Switch..... OFF

C1 And C2 Demand Pump Selectors OFF

Avoids system contamination and/or pump damage and prevents an air system low flow condition.

Right Demand Pump Selector..... OFF

Avoids system contamination and/or pump damage.

Handling qualities are degraded.

Pitch and roll control capability is reduced with fewer operating control surfaces.

Plan to land at the nearest suitable airport.

Ground Proximity Flap Override Switch.....OVRD

(Continued)

Note: Inoperative items:

- Multiple flight control surfaces
- Stabilizer
- Autoland
- Main landing gear hydraulic operation
- Right thrust reverser
- Autobrake
- Normal and alternate brakes
- Main gear steering.

Note: Plan additional time for slower slat and flap operation.

Note: Slats will extend beyond midrange when airspeed is below 239 knots. For go-around, do not exceed 239 knots until slats retract to midrange.

Note: Use flaps 20 and $V_{REF}30 + 20$ for landing. Higher approach speeds improve aircraft-maneuvering characteristics.

Note: Crosswind limit for landing is 20 knots. Less control authority decreases crosswind-landing capability

Note: Roll rate may be reduced inflight. Speedbrake effectiveness may be reduced inflight and during landing.

Note: Do not arm speedbrake lever. Prevents inadvertent inflight extension.

Note: Manually extend speedbrakes after landing.

Note: For go around, observe gear EXTEND limit speed (270 k / .82 Mach).

Do not accomplish the following checklists:

AUTO SPEEDBRAKE
FLIGHT CONTROLS
SPOILERS
STABILIZER

(Continued)

◀ ◀ ◀ ◀ ◀ DEFERRED ITEMS ▶ ▶ ▶ ▶ ▶

==> APPROACH CHECKLIST

Initiate flap extension as required.

Landing Gear Lever DN

Ensures nose gear extension if pressure still exists in that part of the system.

Alternate Gear Switch DOWN

Push and hold for 1 second.

Reduction of airspeed to below 240 knots may be necessary for landing gear to lock down.

Do not accomplish the following checklists:

FLAPS PRIMARY FAIL
SLATS PRIMARY FAIL
GEAR DOOR

* * * *

HYD QTY LOW C, L, R

Condition: Hydraulic quantity is low.

* * * *

RAT UNLOCKED

Condition: Ram air turbine is not stowed and locked.

* * * *

2.14 - LANDING GEAR**TABLE OF CONTENTS**

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☐ **ANTISKID**

Condition: A fault is detected in the antiskid system.

Note: Autobrake system is inoperative. Use minimum braking consistent with runway conditions to reduce the possibility of tire blowout.

* * * *

AUTOBRAKE

Condition: Autobrake is disarmed or inoperative.

* * * *

☐ **BRAKE SOURCE**

Condition: Normal, alternate, and reserve brakes are not available.

Note: Only accumulator pressure is available for braking. During landing rollout, apply steady, increasing brake pressure and hold to a full stop. Do not taxi.

* * * *

☐ BRAKE TEMP

Condition: Temperature of one or more brakes is excessive.

IF In Flight:



Observe gear EXTEND limit speed (270K/.82M).

Landing Gear Lever DN

Allows cooling air to flow around brakes.

When **BRAKE TEMP** message no longer displayed:

OR

Wait 8 minutes.

Ensures sufficient cooling time.

Landing Gear Lever UP

* * * *

IF On The Ground:



Refer to BRAKE COOLING SCHEDULE in the Performance In-flight
Section 5 for required cooling time.

* * * *

☐ **GEAR DISAGREE**

Condition: Gear position disagrees with landing gear lever position.

IF Landing Gear Lever Up:



Note: Observe gear EXTEND limit speed (270K/.82M).

Note: Flight with gear down increases fuel consumption and decreases climb performance.

The decision of where to land and when to extend the landing gear should be made after evaluating terrain, fuel burn, weight, weather, airport facilities, and other relevant factors.

OR

Do not accomplish the following checklists:

AUTO SPEEDBRAKE
GEAR DOOR



* * * *

IF Landing Gear Lever Down:

Observe gear EXTEND limit speed (270K/.82M).

Alternate Gear Switch..... DOWN

Push and hold for 1 second.

Releases gear uplocks and gear door locks allowing gear to free-fall.

Reduction of airspeed to below 240 knots may be necessary for landing gear to lock down.

Do not accomplish the following checklist:

GEAR DOOR

Wait 30 seconds

IF Any Gear Remains Up Or In Transit:

Plan to land on available gear.

Ground Proximity Gear Override Switch..... OVRD

Note: Use flaps 30 for landing. Provides slowest landing speed.

Note: Do not arm speedbrake lever.

Note: Manually extend speedbrakes after landing. Allows coordinated speedbrake extension.

(Continued)

- - - - - WHEN AT PATTERN ALTITUDE - - - - -

Outflow Valve SwitchesMAN

Outflow Valve Manual Switches..... OPEN

Position outflow valves fully open to depressurize aircraft.

Fuel Pump Switches (All)..... OFF

Reduces possibility of fire.

Do not accomplish the following checklists:

CABIN ALTITUDE AUTO

FUEL PRESS ENG R

FUEL PRESS ENG L

*** * * ***

**PARTIAL OR GEAR UP
LANDING TECHNIQUES****General**

Consideration should be given to the best suitable airport with adequate fire-fighting capability.

Coordinate with all ground emergency facilities. For example, the fire trucks normally operate on a common VHF frequency with the aircraft and can advise the crew of aircraft condition during landing.

Consideration should be given to landing with as many gear down as possible. Circumstances will influence the pilot's decision as to whether a partial gear-up landing should be made. If a choice of configuration is available, the decision will be determined by the amount of landing gear available, the conditions at the landing field, time of landing, available facilities, aircraft load distribution, and controllability. In all cases, reduce weight as much as practicable by burning off fuel to provide the slowest possible touchdown speed.

Fuel pressure to the engines should be shut off before the engines contact the ground to reduce the possibility of fire. If the APU is running, it also should be shut down prior to landing.

Landing Runway

Consideration should be given to the best suitable airport with adequate runway and fire fighting capability. Foaming the runway is not recommended. Tests have shown that foaming provides minimal benefit and it takes approximately 30 minutes to replenish the fire truck's foam supply.

Landing Techniques

Plan a normal approach, extending maximum (for configuration) flaps as for a normal landing and normal rate of descent. Use the normal V_{REF} speed plus wind velocity and gust factor corrections.

The landing should be made with all available gear down and every effort should be made to keep the aircraft on the hard surfaced runway. This will minimize damage to the aircraft and facilitate passenger evacuation.

Deployment of speedbrakes at touchdown with one main landing gear retracted is not recommended unless stopping distance is critical.

Both Main Gear Down (Nose Gear Up)

If possible, move C.G. aft by relocating passengers.

Stabilize V_{REF} speed early and maintain normal rate of descent. With touchdown at the normal 1,000 feet point, check the speedbrakes deployed. Use normal reverse. Hold nose up as long as possible after touchdown but lower the nose gently before losing elevator effectiveness. Normal braking can be used to minimize structural damage. When the aircraft is stopped, place the fuel control switches to CUTOFF, pull the engine and APU fire handles and discharge fire bottles (if necessary), at the Captain's command.

Nose Gear Only Extended

Establish a normal approach with flaps maximum for condition. Land in the center of the runway. Use normal approach and flare attitude maintaining back pressure on the control column until ground contact.

The engines will contact the ground prior to the nose gear. Move the speedbrake lever to UP after touchdown. Select speedbrake lever DOWN, and the fuel control switches to CUTOFF. Pull the engine and APU fire handles and discharge the fire bottles (if necessary) at the Captain's command.

All Gear Up Or Partially Extended

Use a normal approach and flare attitude. The engines will contact the ground first. After touchdown, move speedbrake lever to UP. There is adequate rudder available to maintain directional control during initial ground slide. Select speedbrake lever down, and the fuel control switches to CUTOFF. Pull the engine and APU fire handles and discharge fire bottles (if necessary) at Captain's command.

One Main Gear Only Extended

Establish a normal approach with flaps maximum for condition.

Land the aircraft on the side of the runway that corresponds to the available gear down. Deployment of speedbrakes at touchdown with one main landing gear retracted is not recommended unless stopping distance is critical. The landing gear will absorb the initial shock and delay touchdown of the engine. After touchdown, manually extend the speedbrakes to the mid position for maximum lateral control. Maintain wings level as long as possible. Braking and reverse thrust on the engine opposite the unsupported wing may be used as required to keep the aircraft rolling straight.

Select speedbrake lever down, and the fuel control switches to CUTOFF prior to the engine touching the ground. Pull engine and APU fire handles and discharge fire bottles (if necessary) at Captain's command.

One Main Gear Down And Nose Gear Extended

Establish a normal approach with flaps maximum for condition.

Land the aircraft on the side of the runway that corresponds to the available gear down. Deployment of speedbrakes at touchdown with one main landing gear retracted is not recommended unless stopping distance is critical. The landing gear will absorb the initial shock and delay touchdown of the engine. After touchdown, manually extend the speedbrakes to the mid position for maximum lateral control. Maintain wings level as long as possible. Braking and reverse thrust on the engine opposite the unsupported wing may be used as required to keep the aircraft rolling straight.

Select speedbrake lever down, and the fuel control switches to CUTOFF prior to the engine touching the ground. Pull engine and APU fire handles and discharge fire bottles (if necessary) at Captain's command.

After Stop

Initiate the passenger evacuation procedure.

* * * *

☐ **GEAR DOOR**

Condition: One or more gear doors are not closed.

Note: Observe gear EXTEND limit speed (270K/.82M).

* * * *

☐ **MAIN GEAR BRACE L, R**

Condition: Affected main gear is down with one brace unlocked.

Ground Proximity Gear Override Switch.....OVRD

Note: Use flaps 30 for landing. Provides slowest landing speed.

Note: Do not arm speedbrake lever.

Note: Manually extend speedbrakes after landing. Allows coordinated speedbrake extension.

----- **WHEN AT PATTERN ALTITUDE** -----

Fuel Pump Switches (All)OFF

Reduces possibility of fire.

Do not accomplish the following checklists:

FUEL PRESS ENG L

FUEL PRESS ENG R

* * * *

MAIN GEAR STEERING

Condition: Main gear steering is unlocked when centered.

* * * *

☐ **RESERVE BRAKES/STRG**

Condition: Reserve brakes, normal nose gear extension, and nose wheel steering may not be available.

Note: Plan for possible alternate gear extension. Do not taxi with loss of steering.

* * * *

☐ **TIRE PRESS**

Condition: One or more tire pressures are not normal. Check the GEAR SYNOPTIC for tire pressures and brake temperatures. Do not takeoff with an abnormal tire pressure indication. If airborne, for either high or low tire pressure, make a normal approach and landing. The deflation of a single tire on either main gear or the nose gear presents no significant problems and the remaining tire(s) will support the weight of the aircraft during landing. In all cases, have the tire checked for damage / inflation prior to extended taxiing.

* * * *

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AIRSPEED LOW

Condition: Airspeed is below minimum maneuvering speed.

* * * *

ALTITUDE ALERT

Condition: Aircraft has deviated from the selected altitude.

* * * *

ALTITUDE CALLOUTS

Condition: Altitude callouts are no longer provided.

* * * *

CONFIG DOORS

Condition: An entry, forward cargo, or aft cargo door is not closed and latched and locked when either engine's thrust is in the takeoff range on the ground.

* * * *

CONFIG FLAPS

Condition: Flaps are not in a takeoff position when either engine's thrust is in the takeoff range on the ground.

* * * *

CONFIG GEAR

Condition: Any landing gear is not down and locked when either thrust lever is closed below 800 feet radio altitude or when flaps are in a landing position.

* * * *

CONFIG GEAR STEERING

Condition: Main gear steering is unlocked when either engine's thrust is in the takeoff range on the ground.

* * * *

CONFIG PARKING BRAKE

Condition: Parking brake is set when either engine's thrust is in the takeoff range on the ground.

* * * *

CONFIG RUDDER

Condition: Rudder trim is not centered when either engine's thrust is in the takeoff range on the ground.

* * * *

CONFIG SPOILERS

Condition: Speedbrake lever is not DOWN when either engine's thrust is in the takeoff range on the ground.

* * * *

CONFIG STABILIZER

Condition: Stabilizer is not within the greenband when either engine's thrust is in the takeoff range on the ground.

* * * *

☐ **CONFIG WARNING SYS**

Condition: A fault is detected in the configuration warning system.

Note: Radio altitude voice callouts and other aural alerts may not be available.

* * * *

☐ **GND PROX SYS**

Condition: Ground proximity alerts may not be provided.

Note: Some or all ground proximity alerts are not available. Ground proximity alerts which occur are valid.

* * * *

OVERSPEED

Condition: Airspeed has exceeded V_{MO}/M_{MO} .

* * * *

☐ TAIL STRIKE

Condition: A tail strike has been detected.

Outflow Valve SwitchesMAN

Outflow Valve Manual Switches..... OPEN

Position outflow valves fully open to depressurize aircraft.

Plan to land at the nearest suitable airport.

Do not accomplish the following checklist:

CABIN ALTITUDE AUTO

* * * *

TCAS

Condition: TCAS has failed.

* * * *

TCAS OFF

Condition: TCAS is in standby mode.

* * * *

TCAS RA CAPTAIN, F/O

Condition: TCAS cannot display RA guidance on the affected PFD.

* * * *

TERR OVRD

Condition: Ground proximity terrain OVRD switch is in OVRD.

* * * *

☐ **TERR POS**

Condition: Terrain position data has been lost.

Note: Position data for the ND terrain map and look ahead terrain alerts are lost. Ground proximity alerts which occur are valid.

* * * *

☐ **WINDSHEAR SYS**

Condition: Windshear alerts may not be provided.

Note: Some or all windshear alerts are not available. Windshear alerts which occur are still valid.

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SEC 2		26	05/01/02	SEC 2.1	
TOC-1	07/01/98	* 27	11/01/02	* TOC-1	11/01/02
TOC-2	07/01/98	* 28	11/01/02	* TOC-2	11/01/02
		29	05/01/02		
		30	05/01/02	* 1	11/01/02
SEC 2.0				* 2	11/01/02
TOC-1	05/01/02	31	05/01/02	* 3	11/01/02
TOC-2	05/01/02	32	05/01/02	* 4	11/01/02
		33	05/01/02		
* 1	11/01/02	34	05/01/02	SEC 2.2	
* 2	11/01/02	35	05/01/02	* TOC-1	11/01/02
* 3	11/01/02	36	05/01/02	* TOC-2	11/01/02
4	05/01/02	37	05/01/02		
5	05/01/02	* 38	11/01/02	1	07/01/99
6	05/01/02	* 39	11/01/02	2	07/01/99
7	05/01/02	40	05/01/02	3	11/01/00
8	05/01/02			4	07/01/99
9	05/01/02	41	05/01/02	5	07/01/99
10	05/01/02	42	05/01/02	6	07/01/99
		43	05/01/02	7	05/01/00
11	05/01/02	* 44	11/01/02	8	05/01/00
12	05/01/02	45	05/01/02	9	07/01/99
13	05/01/02	* 46	11/01/02	10	11/01/01
14	05/01/02	47	05/01/02		
15	05/01/02	48	05/01/02	11	07/01/99
16	05/01/02	* 49	11/01/02	12	07/01/99
17	05/01/02	50	05/01/02	13	07/01/99
18	05/01/02			14	11/01/00
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25	05/01/02	58	05/01/02		

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07 OCT 2002

DON R. KLOS

Principal Operations Inspector

* Asterisk indicates page(s) revised or added by the current revision.

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AUTOMATED FLIGHT OPERATIONS**GENERAL**

Autopilot Flight Director System (AFDS) and Flight Management Computer (FMC) systems are designed to increase flight precision and reduce crew workload. Pilots must be well versed in flying the B777 using all levels of automation - from raw data hand flying through auto flight guidance using the full LNAV and VNAV capabilities of the FMC. When an automated function improves precision or reduces workload, its use may be desirable. However, if an automated function does not complement a given situation, good judgment supports use of a more basic mode. FMC LNAV and VNAV automated flight guidance functions are tools to be used by the pilot when and if they are appropriate. Continental expects B777 pilots to match the level of automation used with the flight dynamics of the situation. The pilot's assessment of the situation, and good judgment, determine that level.

Below 10,000' MSL, due to the increased need to clear for visual traffic, it is highly desirable to use the mode control panel (MCP) functions in order to limit heads-down time. Maximum emphasis should be placed on programming the FMC with all known departure and climb information while on the ground, and all known descent and landing information prior to descending below 10,000' MSL. While one pilot programs, the other pilot assumes total responsibility for clearing whenever the aircraft is in motion.

Closely monitor altitude during all altitude changes to ensure that the flight guidance system acquires and/or commands levels off at the correct altitude. Use standard callouts, crew coordination, and crosscheck MCP settings with flight instruments to detect any uncommanded changes.

PHILOSOPHY OF AUTOMATION

Continental's goal for automation is to increase safety, efficiency, and improve situational awareness, while reducing pilot workload. Pilots must be proficient in all capabilities of their aircraft, including the automated systems, and must use their judgment as to how and when those systems are employed.

LEVELS OF AUTOMATION		
I	Hand Flown	Raw Data
II	Hand Flown	Flight Guidance
III	Autopilot / Autothrottle	Flight Guidance
IV	LNAV / VNAV	Flight Guidance

Use automation at the level that it best improves situational awareness, reduces workload, and provides for most efficient flight performance. The level of automation used is dynamic – change the level (up or down) if the current level employed is detracting from the situation (i.e., increasing workload).

Pilots must be aware that consistent use and reliance on automation levels III and IV throughout the flight regime will degrade basic flying skills. Therefore, pilots must continue to maintain proficiency by using all levels of automation on a regular basis.

CREW RESOURCE MANAGEMENT

Automated aircraft, by the nature of the equipment employed, require well developed crew coordination.

Effective resource management recognizes that human error is likely. The goal is to reduce the probability that serious errors will occur, and to promptly detect and correct mistakes when they do happen.

As always, the captain is the final decision making authority on the aircraft; however, it is the responsibility of all crewmembers to contribute to the decision making process to help ensure that the best decisions are made.

Captains set the tone on the flight deck. Their initial crew introduction and briefing is an important leadership opportunity and they should encourage all crewmembers to provide information about operational issues. All flight deck crewmembers must bring any information that has any impact on operational safety to the attention of the captain.

If any crewmember has *any* doubts about the flight's safety, they must speak up with appropriate persistence until there is some resolution. All crewmembers should balance assertiveness with tact. The issue must always be *what* is right, not *who* is right.

The following specific automation-related CRM skills will be trained and developed to be employed as an integral part of routine flight deck procedures:

- Plan and brief automation modes and configurations.
- Establish guidelines for PF and PM duties for the operation of automated systems.
- Plan workload and allow sufficient time for programming tasks. Limit programming during critical phases or conditions of flight.
- Verbalize entries and changes to automated systems.
- Maintain an awareness of the automation modes selected by crew or initiated by FMS.
- Change level of automated systems (up or down) to increase situational awareness and avoid work overload.

AUTOMATION EMPLOYMENT

FMC Lateral Navigation Accuracy

The FMC's with CDU's meets regulatory requirements for an Area Navigation System when used in the GPS/radio updating mode. In the GPS/auto radio updating mode, and in conjunction with the map display of the ND, the FMC and CDU may be used for enroute and terminal area navigation and RNAV approaches, and as a supplement to primary navigation means when conducting other types of Non-Precision approaches. The FMC's select the best GPS/VOR/LOC/DME sources for updating and tunes both VHF navigation radios.

In a dual FMC, triple CDU configuration, and in conjunction with GPS and the ADIRU, the systems are approved for use as a sole means of navigation in areas without radio coverage.

Map Shift

FMC position or map shift is a result of an erroneous FMC position caused by periods of operation with inaccurate navaid updates from erroneous navaids. Because FMC position errors are possible when accurate FMC updating is not occurring, periodic monitoring of ground-based navaid raw data is desirable.

MCP / CDU Inputs

It is imperative that changes on the Mode Control Panel (MCP) and on the Control Display Unit (CDU) of the Flight Management Computer (FMC) be accomplished accurately. Flight deck workload, autopilot status, communications requirements, etc. can all influence which pilot will perform certain functions at any given time. The guidelines set forth below establish the preferred procedures. If the pilot normally expected to accomplish a given task is distracted by other duties or flight deck workload / convenience so dictates, it is permissible for the other pilot to make the appropriate changes. In this event, the pilot making the changes must verbally state the changes made. Regardless of which pilot makes the inputs, all changes to routings, reroutings, and restrictions must be confirmed by both pilots at the time they are entered in the MCP/CDU.

When clearances are received they should be complied with in the most expeditious manner possible. This may require an initial aircraft input using the MCP followed by FMC programming to allow return to an LNAV/VNAV mode of operation.

Autopilot ON

While the autopilot is ON, all MCP and CDU operations that affect the aircraft's flight path are normally done by the PF. If desired, the PF can request these steps be done by the PM.

Autopilot OFF

While the autopilot is OFF, all MCP and CDU operations should be called for by the PF, and executed by the PM.

Altitude Alerting

The Altitude Alerting system shall be used during all phases of flight to assist the flight crew in altitude awareness, and to prevent deviation from assigned clearances. During climb and descent, the flight crew shall set the next clearance altitude in the Altitude Selector Window. During VNAV climbs or descents where a clearance is received containing multiple crossing restrictions, the Altitude Selector shall be set at the highest or lowest altitude clearance, as applicable, and the aircraft monitored for compliance with any intermediate altitude constraints.

While the autopilot is ON, the PF will set new clearance altitudes in the Altitude Selector Window. While the autopilot is OFF, the PM will select the cleared altitude in the Altitude Selector Window. Both pilots will verbally and visually acknowledge the cleared altitude set in the MCP.

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STANDARD CALLOUTS

The following chart identifies the standard callouts required during flight, both instrument (IMC) and visual (VMC). Altitude callouts above 100 feet AGL are made with reference to the barometric altimeters. Callouts at or below 100 feet AGL are made with reference to radio altimeters. During the final approach segment, the PM will monitor the instruments and call out significant deviations from the intended target airspeed, approach course, glideslope, and sink rate. The PM will also monitor instruments for warning flags and call out any flag in view. If the designated crewmember is distracted at the time a standard callout is required, the other pilot will make the call.

Note: For specific calls relating to flight guidance, see the applicable procedure.

STANDARD CALLOUTS

CONDITION/LOCATION		CALLOUT	
Takeoff	Takeoff Power Set	PF:	"CHECK POWER"
		PM:	"POWER SET ____%"
	100 Knots	PM:	"100 KNOTS"
	5 Knots Prior To V ₁	PM:	"V ₁ "
	V _R	PM:	"ROTATE"
	Positive Rate Of Climb	PF or PM:	"POSITIVE RATE"
		PF:	"GEAR UP"
Climb And Descent	Passing Transition Altitude	PM:	"____ FEET ____ SET"
	1000' Above / Below Assigned Altitude	PM:	State actual altitude for assigned altitude, i.e., "SIX THOUSAND FOR SEVEN THOUSAND."
Approach	1000' ATDZ	PM:	"1000"
		PF:	"CHECK MISSED APPROACH ALTITUDE"
	500' ATDZ	PM:	"500"
	400' ATDZ		"400"
	300' ATDZ		"300"
	200' ATDZ		"200"
IMC (Except Monitored)	100 Feet Prior To Minimums	PM:	"APPROACHING MINIMUMS"
	Reaching Minimums	PM:	"MINIMUMS"
	Strobes and/or Approach Lights, Runway In Sight	PM:	"APPROACH LIGHTS IN SIGHT"
		PM:	"RUNWAY IN SIGHT"
Monitored Approach	100 Feet Prior To Minimums	CAPTAIN: "APPROACHING MINIMUMS, I'M GOING HEADS UP"	
	Landing	CAPTAIN: "I HAVE THE AIRCRAFT"	
All IMC Approaches	100 Feet	PM: "100...50...30...20...10" (Not called if announced by EGPWS alert voice)	
	50 Feet		
	30 Feet		
	20 Feet		
Visual Approaches: At Captain's or PF Discretion	10 Feet		

(Continued)

CONDITION / LOCATION		CALLOUT	
Autoland Approaches	500' ATDZ	PM: "500" PF: "LAND 3" / "LAND 2"	
CAT III Alert Height Profile	100' Prior To AH	Captain: "APPROACHING ALERT HEIGHT, I HAVE THE AIRCRAFT"	
	Alert Height	F/O: "ALERT HEIGHT"	
Missed Approach	Missed Approach Point (MAP)	PM: "MISSED APPROACH POINT" PF: IMC: "MINIMUMS, GOING AROUND" VMC: "GOING AROUND" "FLAPS TWENTY or FIVE" "CHECK POWER" "POSITIVE RATE, GEAR UP" "CHECK MISSED APPROACH ALTITUDE" "LNAV or HEADING SELECT"	
Landing Roll	80 Knots	PM: "80 KNOTS"	
After F/O Landing	When Captain assumes control of the aircraft	Captain: "I HAVE THE AIRCRAFT"	

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PREFLIGHT PROCEDURES**General**

Before accepting an aircraft, a thorough exterior and flight deck inspection shall be made. The responsibility for these checks rests with the Captain. However, at his/her discretion, he/she may delegate the duty to the First Officer or IRO.

A complete exterior inspection will be accomplished on each originating flight or crew change. Subsequent inspections are to be performed at each station in accordance with the EXTERIOR INSPECTION - THROUGH FLIGHT procedure.

Upon arrival at the aircraft, the following procedures are normally accomplished in the designated order:

- Safety Inspection - Exterior
- Safety Inspection – Flight Deck
- Establish Electrical Power And Air Conditioning (if required)
- Exterior Inspection
- Flight Deck Inspection
- Cabin Inspection
- Receiving Aircraft Procedure/Checklist

When operationally efficient during crew changes, the exterior inspection may be accomplished while waiting for passengers and crew to deplane.

SAFETY INSPECTION - EXTERIOR

Either the Captain, First Officer or IRO will conduct an Exterior Safety Inspection on all originating flights and crew changes.

Surfaces and Chocks..... CHECK

Visually check that all movable surfaces are clear and the chocks are in place.

Maintenance Status CHECK

If maintenance is in progress, confer with maintenance personnel to determine if the work will prevent activation of any aircraft systems.

Landing Gear Doors CLOSED

Observe both main and nose landing gear doors closed.

SAFETY INSPECTION – FLIGHT DECK
--

Either the Captain, First Officer or IRO will conduct the Flight Deck Safety Inspection from memory.

Logbook (Aircraft & Cabin) CHECK

Verify maintenance status is acceptable for flight and ensure agreement with authorized dispatch deviations, if required.

Battery Switch ON

Push Battery switch ON and verify **OFF** light extinguished.

The remaining items from Flight Deck Safety Inspection may be omitted if both AC and DC Electrical systems are already powered when the crew arrives at the aircraft.

Hydraulic Panel SET

C1 and C2 PRIMARY Pump Switches OFF

Demand Pump Selectors OFF

Wiper Selectors OFF

Landing Gear Lever DOWN

Alternate Flaps Arm Switch OFF

Alternate Flaps Selector OFF

**ESTABLISH ELECTRICAL POWER AND AIR CONDITIONING
(IF REQUIRED)**

External Power Primary (If Available) ON

Check **EXT PWR AVAIL** light illuminated. Push the External Power switch and observe that the **ON** light comes on.

External Power Secondary (If Available) ON

Check **EXT PWR AVAIL** light illuminated. Push the External Power switch and observe that the **ON** light comes on. If both Primary and Secondary external power is available both switches should be ON.

APU (If Required).....START

Rotate APU selector to **START**; hold momentarily, then release.
Observe APU selector moves to **ON** and APU **FAULT** light is extinguished.

Air Conditioning

APU and Engine Bleed Air Switches AUTO/ON

Isolation Switches AUTO

Pack Control Switches..... AUTO

Trim Air Switch..... ON

Recirc Fan Switches Upper/Lower..... ON

Flight Deck Temperature Control(As Desired) AUTO

Operating With APU Generator and/or Pneumatics Inoperative

Caution: If an external air cart is used, the air cart should be placed on the left side of the aircraft and the right engine will be started first. After the right engine has been started, the air cart should be removed from the vicinity of the aircraft. Plan a cross bleed start for the left engine. If a battery start is required (during which bleed air is only available to the left engine or the left engine must be started first for operational reasons) the external air cart may be positioned on the right side of the aircraft and the left engine started first.

With the APU Generator Inoperative, but APU Pneumatics Available:

- Engine Start: Use external electrical power or BATTERY START procedure, Section 2 Non-Normal.
- Refueling: Use normal procedures.

With APU Pneumatics Inoperative, but APU Generator Available:

- Engine Start: Refer to ENGINE START WITH EXT AIR procedure, Section 2 Non-Normal.

With APU Generator and Pneumatics Inoperative (External Electric Power Not Available):

- Dispatch: Do not dispatch to an airport that does not have the required engine starting equipment. Because of safety considerations, an engine should not be left running during a turnaround.
- Refueling: Normal procedures.
The aircraft may not be refueled with an engine running.
- Engine Start: Use ENG BATTERY START procedure, Section 2 Non-Normal.
- Takeoff: If takeoff must be made in packs OFF configuration, follow the procedure for a PACKS OFF TAKEOFF, Section 2 Non-Normal.

Using Ground Preconditioned Air

The passenger cabin and flight deck may be air conditioned by attaching a pre-conditioned air source to the ground service connection on the underside of the fuselage. This air goes directly into the supply duct manifold for distribution throughout the aircraft.

Before connecting ground air conditioning cart:

PACK switches OFF

Prevents pack operation if bleed air is supplied to aircraft.

RECIRC FANS switches OFF

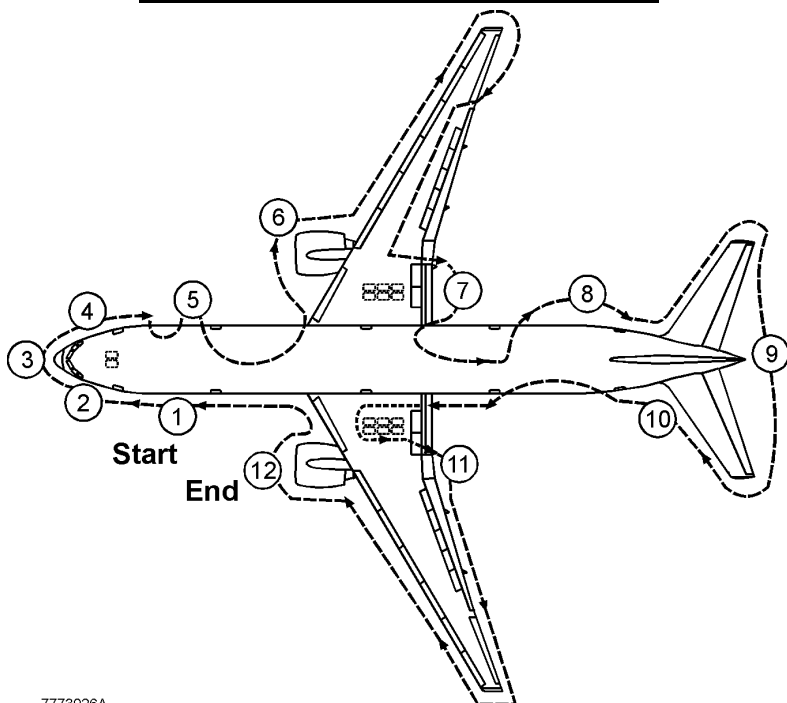
Allows cart to operate at maximum efficiency.

After disconnecting ground air conditioning cart:

PACK switches AUTO

RECIRC FANS switches ON

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EXTERIOR INSPECTION

7773026A

Either the Captain, First Officer or IRO will conduct the Exterior Inspection.

The recommended sequence is to start at the left forward fuselage and proceed in a clockwise direction. During the walk around, observe the general condition of all surfaces, fuselage, empennage, wings, windows, antennas, flight controls, engines, and cowlings. Check particularly for damage, fluid leakage, proper position, and security of access panels. Also verify that crew, passengers, and cargo doors, which are not in use, are closed and the door handles recessed. Check all external lights are clean, with undamaged lenses. Check operation of navigation/position lights.

Check potable water and lavatory fill and drain areas for leakage. If evidence of leakage is found, notify maintenance.

Note: If evidence of fluid leakage or stains is noted at the forward and/or aft lavatory service panel, ground personnel must verify if a leak exists before departure. If a leak is present, repairs must be made, or the affected lavatory must be drained and placarded inoperative.

The flight crew is responsible to insure there are no gear pins installed in any landing gear during the exterior inspection. If any gear pin is installed, it must be removed by maintenance and visually confirmed by the crew prior to departure. The crew is also responsible to insure there is no open entry in the aircraft logbook stating that the gear pins have been installed. All B777 gear pins are stored in the built-in gear pin storage container located in the lower center section of the E/E compartment. The flight crew is not required to visually confirm the 5 gear pins are installed in this container. If the pins are to be installed (only by maintenance personnel), they can be accessed through the E/E compartment door in the nose gear well or via the E/E door located in the cabin floor near door 1L.

① Left Mid Fuselage

- Pack inlet and exhaust
- Negative pressure relief vents
- Wing illumination light
- Static ports
- Positive pressure relief valves
- Forward outflow valve
- Crew oxygen thermal discharge disc

② Left Forward Nose

- L pitot probe
- L ice detector probe
- TAT probe
- L AOA probe

③ Nose Section / Gear Area

- Windshield wipers
- Radome and latches
- Forward access door
- Nose gear strut extension
- NLG downlock safety pin -- Removed
- Nose wheel tires
- Steering cables
- Main E & E access door
- APU control panel
- Steering safety pin

④ Right Forward Nose

- Center pitot probe
- Right ice detector
- Right pitot probe
- Right AOA probe
- External power door

⑤ Right Mid Fuselage

- Forward cargo door
- Static ports
- Pack air inlets and outlets
- Wing illumination light

⑥ Right Wing Area and Engine

- Landing light
- Taxi and turnoff light
- Engine strut
- Thrust reverser and sleeve
- EEC static ports
- Cowling and fasteners
- Fan blades
- PT 2 probe
- Reverser blocker doors
- AFT fan blades
- Wing under surface area
- Leading edge slats and flaps
- Fueling adapter panel
- Fuel vent scoop
- Navigation lights
- Strobe lights
- Static discharge wicks
- Aileron and flaperon
- Fuel jettison
- Inboard and outboard flaps and flap drives

⑦ Right Main Gear

- Wheels and tires
- Landing gear strut extension
- Down lock braces
- MLG Drag brace downlock safety pin – Removed
- MLG Side brace downlock safety pin -- Removed
- Gear doors – closed
- Gear uplatch
- Hydraulic leaks

⑧ Right AFT Fuselage

- RAT door
- Drain mast for APU fuel line shroud and center wing dry bay
- AFT cargo door
- Bulk cargo door
- Static ports

⑨ Tail Area

- Lower fuselage structure and tail strike sensor
- Static ports
- APU inlet door
- APU oil/fuel drain
- APU services door
- Vertical/horizontal surfaces
- Static discharge wicks
- Top surfaces of both wings and tail
- APU exhaust
- Strobe light

⑩ Left AFT Fuselage

- AFT outflow valve
- Water drains, service doors, waste vents
- Air demand pump exhausts (2)

⑪ Left Main Gear

- Hydraulic leaks
- Gear uplatch
- Gear doors – closed
- MLG Drag brace downlock safety pin – Removed
- MLG Side brace downlock safety pin -- Removed
- Down lock braces
- Landing gear strut extension
- Wheels and tires

⑫ Left Wing Area and Engine

- Inboard and outboard flaps and flap drives
- Fuel jettison nozzle
- Aileron and flaperon
- Static discharge wicks
- Strobe light
- Navigation lights
- Fuel vent scoop
- Fueling adapter/control panel
- Leading edge slats and flaps
- Wing under surface area
- AFT fan blades
- Reverser blocker doors
- PT 2 probe
- Fan blades
- Cowlings and fasteners
- EEC static ports
- Thrust reverser and sleeve
- Engine strut
- Taxi and turnoff light
- Landing light

Exterior Inspection Complete

FLIGHT DECK INSPECTION

The following Flight Deck items should be checked:

- Circuit Breakers
- Overhead Maintenance Panel. The following items are checked on the Overhead maintenance panel during the flight deck inspection:
All Guarded Switches GUARD CLOSED
Flight Control VALVE CLOSED Lights..... EXTINGUISHED
Cockpit Voice Recorder CHECKED
Push test button and hold for 5 seconds. Observe meter needle remains in green band entire time test button is depressed. With headset on and plugged into voice recorder test monitor jack, speak in a conversational tone and listen for same words played back.
Cargo Temperature Selectors..... HIGH
- Escape Rope (Right)
- Crew Life Vests (Right)
- Navigation Kit / Publications (Checklists, Manuals, etc.)
- Emergency Medical Kit
- Protective Breathing Equipment (PBE)
- Crash Axe
- Fire Extinguisher
- Headsets and Microphones
- Crew Life Vests (Left)
- ACM Oxygen Mask (Test Not Required)
- Spare roll printer paper
- Escape Rope (Left)
- Crew Baggage Stowed

CABIN INSPECTION

The Captain will ascertain from Flight Attendant A that the Flight Attendants have conducted a thorough inspection of the cabin, including all emergency equipment as described in Section 6.1, AIRPLANE GENERAL, and that all required equipment is in serviceable condition. On through flights when the crew keeps the same aircraft, the cabin inspection is not required.

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Note: If **CHECKLIST DISABLED** is displayed on MFD after attempting to select a checklist, accomplish the ECL Reset procedure on back of this card.

**Continental Airlines
B777 Normal Checklist**

RECEIVING AIRCRAFT

<u>F/O Challenge</u>	<u>Captain Respond</u>
Oxygen	CHECKED, SET, 100% (F, C, I)
Altimeters & Flt. Inst.....	SET, CHECKED (F, C)
Parking Brake	SET
Fuel Control Switches.....	CUTOFF
Transponder	STANDBY
Log Book / ETOPS.....	CHECKED & ON BOARD
Flight Attendant & Pilot Briefings	COMPLETE

BEFORE START

<u>F/O Challenge</u>	<u>Captain Respond</u>
Cockpit Windows.....	CLOSED & LOCKED (F, C)
Seat Belt Sign.....	ON
Hydraulic Pumps.....	ON / AUTO
Fuel.....	___ REL, ___ ON BOARD
Fuel Pumps.....	ON
Beacon.....	ON
MCP	SET
CDU / Reference Speeds.....	SET (F, C)
Trim.....	___ UNITS, ZERO, ZERO
Flight Controls	CHECKED
Doors	AUTO (F, C)

AFTER START

<u>F/O Challenge</u>	<u>Captain Respond</u>
Engine Anti-Ice.....	(AS REQUIRED)
Recall	CHECKED
Autobrake	RTO
Flaps.....	SET ___
Flight Deck Door	CLOSED & LOCKED

BEFORE TAKEOFF

<u>F/O Challenge</u>	<u>F/O Respond</u>
Departure Briefing	COMPLETE
Takeoff Announcement	CABIN READY
Flaps.....	___
Takeoff Check (If Installed)	CHECKED
Transponder	TA/RA

AFTER TAKEOFF

<u>PM Challenge</u>	<u>PM Respond</u>
Gear.....	UP
Flaps.....	UP

IN RANGE

<u>PM Challenge</u>	<u>PM Respond</u>
Seat Belt Sign	ON
Altimeters & Flt. Inst.....	SET, CHECKED (PM, PF)
Reference Speeds	SET (PM, PF)
Autobrake	SET
Recall & Notes.....	CHECKED
Arrival Briefing.....	COMPLETE

APPROACH

<u>PM Challenge</u>	<u>PM Respond</u>
Radios & Courses	IDENTIFIED & SET (PM, PF)
Altimeters.....	SET (PM, PF)
Landing Announcement.....	CABIN READY

LANDING

<u>PM Challenge</u>	<u>PM Respond</u>
Speedbrake.....	ARMED
Gear.....	DOWN
Flaps.....	___

AFTER LANDING

<u>F/O Challenge (Silent)</u>	<u>F/O Respond (Silent)</u>
APU	(AS REQUIRED)
Anti-Ice	(AS REQUIRED)
Exterior Lights.....	(AS REQUIRED)
Radar	OFF
Autobrake	OFF
Speedbrake.....	DOWN
Flaps.....	UP
Transponder	STANDBY

PARKING

F/O Challenge**Captain Respond**

Fuel Control Switches CUTOFF
Parking Brake(AS REQUIRED)
Seat Belt Sign OFF
Hydraulic SystemSET
Fuel Pumps OFF
Beacon OFF
Flight Directors..... OFF
Log Book / FOB / ACARSCOMPLETED
ADIRU OFF

TERMINATION

Either Pilot Challenge**Either Pilot Respond**

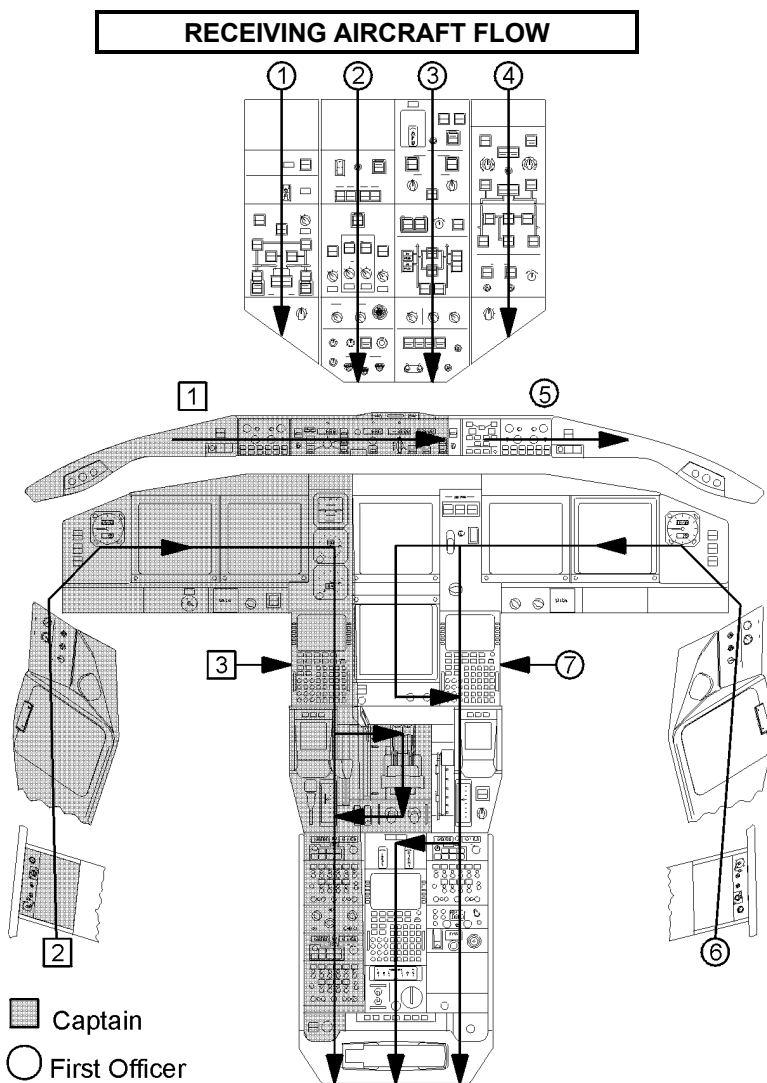
EMER LIGHTS OFF
Window Heat..... OFF
Packs..... OFF
APU / EXT Power.....(AS REQUIRED)
Battery Switch(AS REQUIRED)

ECL RESET PROCEDURE

On Any CDU:

Menu..... SELECT
Maint Info Display SELECT
Page 2 SELECT
31 Maintenance Task SELECT
Checklist Function (Bottom of Page)..... ENABLE

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LEGEND: Shaded area defines captain's area of responsibility.
 Unshaded area defines first officer's area of responsibility.

RECEIVING AIRCRAFT PROCEDURE

The following RECEIVING AIRCRAFT checklist defines the procedure to be conducted before each flight. Division of responsibility between the Captain and First Officer is also defined. The procedure is normally conducted in the designated order; however, variations in order are acceptable. The procedure follows the sequence of the flow diagram.

Each pilot's RECEIVING AIRCRAFT flow may be initiated once their departure from the flight deck is no longer anticipated.

The Captain shall call for the RECEIVING AIRCRAFT checklist when there are no distractions on the flight deck.

F/O Challenge	RECEIVING AIRCRAFT	Capt. Respond
Oxygen	CHECKED, SET, 100% (F, C, D)	
Altimeters & Flt. Inst.	SET, CHECKED (F, C)	
Parking Brake.....	SET	
Fuel Control Switches	CUTOFF	
Transponder.....	STANDBY	
Log Book / ETOPS	CHECKED & ON BOARD	
Flight Attendant & Pilot Briefings.....	COMPLETE	

FIRST OFFICER PROCEDURE

F/O Challenge

Capt Respond

The following procedures are accomplished in their entirety on every flight.

ADIRU Switch (Flow) ON

For all flights, a full alignment is recommended. AIRCRAFT MUST BE STATIONARY.

Verify **ON BAT** and **OFF** lights extinguished.

Right CDU (Flow).....SET

Init Ref Key..... PUSH

Index Line Select Key PUSH

Ident Line Select Key..... PUSH

Ident Page CHECK

Verify aircraft information correct and active date current.

Pos Init Line Select Key..... PUSH

Verify time correct.

Inertial Position ENTER

Enter REF AIRPORT and GATE (if available).

Enter inertial position using the most accurate latitude and longitude into the box prompts at LSK 5R. This will normally be the GPS position, and will be compared with gate coordinates or ARP.

The box prompts blank when the ADIRU transitions from the alignment to the navigation mode. The box prompts also blank when the aircraft is moving or has not been stationary for a minimum of six minutes.

Dash prompts appear when the ADIRU enters the automatic realignment mode on the ground. New position entries can be made during the ADIRU automatic realignment. New entries are displayed for 2 seconds. After 2 seconds, dashes are displayed to allow entry of another position if desired.

If an ADIRU position update is desired during an automatic realignment (on ground only) when dash prompts appear on the SET INERTIAL POS line of the POS INIT page, enter the most accurate position.

If Data Link Available:

FMC Pre-Flight Data Link Procedures

The B777 pre-flight data entry process is largely automated to allow critical flight information to be loaded quickly and minimize data entry errors. The following sequence depicts the pre-flight order in which messages arrive, what alert is used, the message destination (ACARS, FMC or printer), the associated on screen prompts and the crew action choices.

To start the process the ACARS must be initialized. A Crew request for initialization is accomplished as follows:

1. Check center radio in DATA mode.
2. Select COMM from the DSP on the desired MFD.
3. Select COMPANY.
4. Select INITIALIZE.
5. Select SEND.

Sending a company Initialize request signals the host that the crew is on the flight deck and starts an automated process in motion which arms the system to deliver the following messages to the FMC or printer as indicated. These messages are annunciated as indicated in the message alert column.

FMC / ACARS / Printer Pre-Flight Data Link Messages

MESSAGE	DESTINATION	WHEN UPLINKED	MESSAGE ALERT	CHIME	CREW ACTION/PROMPT
INITIALIZE	COMPANY	After Auto INIT requested	EICAS	YES	VERIFY FLIGHT DATA
RTE1 (2) UPLINK	FMC	After COMPANY INIT received. Time variable.	EICAS & CDU	YES	<LOAD or PURGE> Followed by Activate/Execute
WIND DATA UPLINK	FMC	Within 3 minutes of Route Uplink	EICAS & CDU	YES	<LOAD + Execute 4 altitudes per w/p loaded
PDC	PRINTER	20 minutes prior to departure.	EICAS Printer	YES	VERIFY ACTIVE ROUTE
PERF INIT	FMC	8 minutes prior to departure.	EICAS & CDU	YES	<ACCEPT or REJECT>
TAKEOFF REF UPLINK	FMC	8 minutes prior to departure.	EICAS & CDU	YES	<ACCEPT or REJECT>
ACCULOAD	PRINTER	5 minutes prior to departure.	EICAS Printer	YES	Use hard copy to Verify PERF and T/O Data

1. If a ROUTE has been manually entered and is active, a subsequent Route uplink will be annunciated as ROUTE 2 UPLINK READY. The crew may select <ROUTE 2 and <LOAD or PURGE> this uplink, then return to <ROUTE 1. ROUTE 2 now remains the **inactive** Route. If the crew desires to make ROUTE 2 active, it must be selected, ACTIVATED and EXECUTED. Route 1 now becomes the inactive route.
2. Normally, the ROUTE Uplink will arrive at the aircraft within 5 minutes after the COMPANY Initialization Uplink. If more than five minutes have elapsed, and the initialize message has not been received, the crew should reselect the SEND prompt. If after an additional five minutes the initialize message has still not been received, select the ROUTE <REQUEST prompt located at LSK 3L on ROUTE page 1. This action will prompt the company computer to re-queue the route uplink. The same action can be accomplished for a wind request using the WIND DATA request prompt on the ACT RTE (1 (2)) DATA page, accessed from the ACT RTE LEGS page.
3. If the TAKEOFF REF UPLINK message is received without the <ACCEPT REJECT> prompts, there may be disagreement between the crew entered FMC runway selection on ROUTE page 1 and the ACCULOAD runway.

Status Display Switch (Flow) PUSH

Status display verify:

- Hydraulic quantities do not display RF or OF (contact Maintenance if they do).
- Oxygen pressure is sufficient for flight.
- If any status message is displayed, refer to the MEL, and contact Maintenance as necessary to resolve the issue.

Note: Some messages may be the result of the ADIRU not being aligned, an individual switch or control not being in the correct position, or a particular component not yet being electrically powered, (such as during electrical load shedding). Recheck for any of these messages once the aircraft is completely powered, the receiving aircraft flows have been completed, and the ADIRU is aligned. Early identification and notification of any mechanical issue is paramount to insure timely resolution.

Engine Display Switch (Flow) PUSH

- Primary engine indications display existing conditions.
- No exceedence values displayed (reset if required by the CANC/RCL switch).
- Verify engine oil quantity 23 quarts minimum prior to engine start.

EICAS Display Check

- Indications – Normal
Verify that the EICAS messages displayed are normal for this phase of ground operations. There will be numerous messages for door lights, hydraulic pumps, etc., however, there should not be any message that will not be resolved by normal preflight and engine start procedures, such as a **BOTTLE 1/2 DISCH ENG** or a **BRAKE TEMP** message. When verified as normal, clear the EICAS messages.

Thrust Asymmetry Compensation Switch (Flow) AUTO

Verify **OFF** light extinguished.

P F C Disconnect Switch (Flow) AUTO (GUARDED POSITION)

Verify **DISC** light extinguished.

Electrical Panel (Flow) SET**Battery Switch (Flow) ON**

Verify **OFF** light extinguished.

IFE/Pass Seats and Cabin Utility Switches (As Installed) ON**APU Generator Switch (Flow) ON**

Verify **OFF** light extinguished.

- APU Selector (Flow)..... START, RELEASE TO ON**
Verify **FAULT** light extinguished.
- Bus Tie Switches (Flow)..... AUTO**
Verify **ISLN** lights extinguished.
- Generator Control Switches (Flow) ON**
OFF and **DRIVE** lights remain illuminated until respective engine is started.
- Backup Generator switches (Flow) ON**
OFF lights remain illuminated until respective engine is started.
- Left Wiper Selector (Flow) OFF**
- Emergency Lights Switch (Flow)..... ARMED (GUARDED POSITION)**
- Service Interphone Switch (Flow)..... OFF**
- Passenger Oxygen On Light (Flow) EXTINGUISHED**
Caution: Switch activation causes deployment of passenger oxygen masks.
- Window Heat Switches (Flow) ON**
Verify **INOP** lights extinguished.
- Ram Air Turbine Unlkd Light (Flow) EXTINGUISHED**
WARNING: Switch activation causes deployment of the ram air turbine.
- Hydraulic Panel (Flow) SET**
- Left And Right Primary Pump Switches (Flow) ON**
Left and right primary pump **FAULT** lights remain illuminated until the respective engine is started.
- C1 And C2 Primary Pump Switches (Flow) OFF**
Verify **FAULT** lights illuminated.
- Demand Pump Selectors (Flow) OFF**
Verify **FAULT** lights illuminated.
- Passenger Sign Panel (Flow) SET**
- No Smoking Selector (Flow)..... OFF**
- Seat Belts Selector (Flow)..... OFF**

Lighting Panel (Flow).....SET

Ovhd/Circuit Breaker Panel Light Controls.....MID POSITION

Dome Light Control (Flow)..... ADJUST

Storm Light Switch (Flow).....AS DESIRED

Master Brightness Switch (Flow) ON

Master Brightness Control (Flow) ADJUST

Glareshield Light Controls (Flow)MID POSITION

Landing Light Switches (Flow)..... OFF

APU Fire Panel (Flow)SET

APU Btl Disch Light (Flow) EXTINGUISHED

APU Fire Switch (Flow).....IN

Verify APU fire warning light extinguished.

Cargo Fire Panel (Flow).....SET

Cargo Fire Arm Switches (Flow)..... OFF

Verify **FWD** and **AFT** fire warning lights extinguished.

Cargo Fire Disch Light (Flow)..... EXTINGUISHED

Fire/Ovht Test Button (Flow)..... PUSH AND HOLD

The fire and overheat detection systems can be tested manually by pushing and holding the **FIRE/OVERHEAT TEST** switch.

The indications for a manual fire and overheat detection system test are:

- The fire bell rings
- The nose wheel well APU fire warning horn sounds (on the ground)
- The EICAS warning message **FIRE TEST IN PROG** is displayed
- These lights illuminate:
 - The master **WARNING** lights
 - The left and right engine fire warning lights
 - The APU fire warning light
 - The nose wheel well APU fire warning light
 - The **FWD** and **AFT CARGO FIRE** warning lights
 - The **LEFT** and **RIGHT FUEL CONTROL** switch fire warning lights

When the test is complete, the EICAS warning message **FIRE TEST PASS** or **FIRE TEST FAIL** replaces the **FIRE TEST IN PROG** message; the switch can be released. The appropriate system EICAS messages are displayed with the **FIRE TEST FAIL** message:

- **DET FIRE ENG (L OR R)**
- **DET FIRE WHEEL WELL**
- **DET FIRE APU**
- **DET OVERHEAT ENG (L or R)**
- **DET FIRE CARGO (FWD or AFT)**

All test messages clear when the test switch is released. If the switch is released with the **FIRE TEST IN PROG** message displayed, the test ends without completing.

Engine Panel (Flow)SET
EEC Mode Switches (Flow)..... NORM
Start/Ignition Selectors (Flow)..... NORM
Autostart Switch (Flow) ON

Verify **OFF** light extinguished.

Fuel Jettison Panel (Flow)SET
Fuel Jettison Nozzle Switches (Flow) OFF

Verify **VALVE** lights extinguished.

Fuel To Remain Selector (Flow)IN
Fuel Jettison Arm Switch (Flow)..... OFF

Verify **FAULT** light extinguished.

Fuel Panel (Flow)SET
Crossfeed Switches (Flow) OFF

Verify **VALVE** lights extinguished.

Fuel Pump Switches (Flow) OFF

Left and right pump **PRESS** lights are illuminated.

Left forward pump **PRESS** light is extinguished if the APU is running.

Both center pump **PRESS** lights are extinguished.

Anti Ice Panel (Flow).....SET

Wing Anti Ice Selector (Flow)..... AUTO

Engine Anti Ice Selectors (Flow) AUTO

Lighting Panel (Flow).....SET

Beacon Light Switch (Flow) OFF

Nav, Logo, And Wing Light Switches (Flow)AS REQUIRED

Indicator Lights Switch (Flow)AS DESIRED

Rnwy Turnoff, Taxi, And Strobe Light Switches (Flow) OFF

Air Conditioning Panel (Flow).....SET

Equipment Cooling Switch (Flow) AUTO

Verify **OVRD** light extinguished.

Recirculation Fans Switches (Flow)ON

Note: Turn **RECIRC FANS** Switches **OFF** if ground preconditioned air is used.

Flight Deck Temp Control (Flow)AUTO (MID POSITION)

Cabin Temperature Control (Flow).....MID POSITION

Pack Switches (Flow) AUTO

Verify **OFF** lights extinguished.

Note: Turn **L** and **R PACK** Switches **OFF** if ground preconditioned air is used.

Trim Air Switches (Flow)ON

Verify **FAULT** lights extinguished.

Bleed Air Panel (Flow)SET

Bleed Isolation Switches (Flow) AUTO

Verify **CLOSED** lights extinguished.

Engine Bleed Switches (Flow)ON

Verify **OFF** lights illuminated.

APU Bleed Switch (Flow) AUTO

Verify **OFF** light extinguished.

Pressurization Panel (Flow).....SET

Outflow Valve Switches (Flow) AUTO

Verify **MAN** lights extinguished.

Landing Altitude Selector (Flow)IN

Right Wiper Selector (Flow)..... OFF

Flight Director Switch (Flow)..... ON

Display Select Panel (Flow)SET

Lwr Ctr Display Switch (Flow)..... PUSH

Right EFIS Control Panel (Flow)SET

MINS Reference And MINS Selectors (Flow)AS DESIRED

Flight Path Vector Switch (Flow)AS DESIRED

Meters Switch (Flow)AS REQUIRED

Baro Reference And Baro Selectors (Flow)SET

Set the local altimeter setting on the PFD.

VOR/ADF Switches (Flow)AS DESIRED

ND Mode Selector (Flow)MAP

ND Center Switch (Flow)AS DESIRED

ND Range Selector (Flow)AS DESIRED

ND Traffic Switch (Flow) ON

Verify **TCAS OFF** indication on ND.

Map Switches (Flow).....AS DESIRED

Right Oxygen Mask Panel..... TEST AND SET

Mask STOWED

Verify doors closed.

Reset/Test Switch PUSH AND HOLD

Verify the yellow cross appears momentarily in the flow indicator.

Reset/Test Switch RELEASE

Verify the yellow cross no longer appears in the flow indicator.

Normal/100% Switch 100%

Window 2 Right (Flow) CHECKED

Verify the lock lever is in the locked (forward) position and the orange indicator is not in view.

Map Light Control (Flow)AS DESIRED

First Officer's Heaters (Flow)SET

Shoulder Control And Foot Selector (Flow)AS DESIRED

First Officer's Side Display Control (Flow)AS DESIRED

F/O Forward Panel Brightness Controls (Flow).....SET

Display Brightness And Fwd Light Controls (Flow)MID POSITION

Right Instrument Source Select Panel (Flow).....SET

Navigation Source Switch (Flow) OFF

Display Control Source Switch (Flow)..... OFF

Air Data/Attitude Source Switch (Flow) OFF

Right Clock (Flow)SET

Time/Date Selector (Flow).....UTC

Right PFD (Flow)..... CHECKED

Flight Mode Annunciation Verify:

- Autothrottle mode is blank
- Roll mode is TO/GA
- Pitch mode is TO/GA
- AFDS status is FLT DIR
- Verify steering bars (Roll centered and pitch +8 degrees).

Right ND (Flow)..... CHECKED

Verify map mode displayed.

Right Inboard Display Selector (Flow).....MFD

FMC Selector (Flow) AUTO

Landing Gear Panel (Flow)SET

Ground Proximity Light (Flow) EXTINGUISHED

Ground Proximity Flap Override Switch (Flow)	OFF
Ground Proximity Gear Override Switch (Flow)	OFF
Terrain Override Switch (Flow)	OFF
Landing Gear Lever (Flow)	DN
Alternate Gear Switch (Flow)	NORM (GUARDED POSITION)
Autobrake Selector (Flow)	RTO
EICAS Display (Flow)	CHECK

Indications Normal, Verify:

- Primary engine indications display existing conditions
- No exceedance values are displayed

MFD (Flow) **CHECK**

Secondary Engine Display Switch (Flow) **PUSH**

Secondary Engine display Verify:

- Secondary engine indications display existing conditions
- No exceedance values are displayed.
- No EICAS messages displayed.

Center Display Control Source Switch (Flow)..... **OFF**

Center Panel Brightness Controls (Flow).....**SET**

Display Brightness Controls (Flow)**MID POSITION**

Flap Position Indication And Flap Lever (Flow).....**AGREE**

Flap position indication is blank when flaps are up.

Alternate Flaps Panel (Flow)**SET**

Alternate Flaps Arm Switch (Flow) **OFF**

Alternate Flaps Selector (Flow)..... **OFF**

Engine Fire Panel (Flow)**SET**

Eng Btl 1 & Eng Btl 2 Disch Lights..... **EXTINGUISHED**

Engine Fire Switches (Flow).....**IN**

Verify **LEFT** and **RIGHT** fire warning lights extinguished.

Center CDU (Flow)MENU

Flight Deck Printer (Flow)SET

Verify **LOW PAPER** light extinguished.

Right Radio Tuning Panel (Flow).....SET

PNL Off Light (Flow)..... EXTINGUISHED

Set Panel (Flow)AS DESIRED

First Officer's Audio Control Panel (Flow)SET

Set Panel (Flow)AS DESIRED

Transponder Panel.....SET

Transponder Altitude Source Selector (Flow)..... NORM

Transponder Mode SelectorSTBY

Flight Deck Door Control Panel (Flow) CHECK

With the door open, illumination of the **OPEN** light alone indicates the door system is functional. Failure of the **OPEN** light to illuminate, or illumination of any other light on the control panel (either steady or flashing) indicates a fault with the door system.

Floor Lights Switch (Flow)AS DESIRED

Aisle Stand Light Controls (Flow).....MID POSITION

Route Key PUSH

Enter:

- Origin
- Destination
- Runway
- Flight number

Dep/Arr Key..... PUSH

Select SID, and appropriate SID transition if applicable.

Route Line Select Key (6R) PUSH

Enter or verify route as applicable.

Dep/Arr Key..... PUSH

Select or verify expected arrival runway, STAR, and transition if applicable.

Route Line Select Key (6R) PUSH

Enter or verify complete route as applicable. Route 2 can be used for Takeoff or ETOPS alternates as required. Route copy can be selected if Takeoff or ETOPS alternates not required.

Activate Line Select Key **PUSH**

Exec Key **PUSH**

Prog Key **PUSH**

Compare total distance with distance on flight plan.

Route Key **PUSH**

Route 2 as desired:

1. Route 1 copy;
2. Take off alternate;
3. ETOPS entries.

Altn Key **PUSH**

Enter the takeoff alternate, if required.

Nav Rad Key **PUSH**

Set/verify navigation radio tuning.

Plan Mode..... **SELECT**

Select the PLAN mode on the EFIS control panel.

Legs Key **PUSH**

Non-loading pilot STEP through the legs.

Right Flight Instruments (Flow).....**SET**

PFD Correct

- Flight instrument indications are correct.
- The **NO V SPD** flag is displayed until V-speeds are selected.
- Verify that no other flags displayed.

Altimeter Set

ND Correct

- Verify no flags displayed.
- Route Displayed, correct

Right Seat (Flow) ADJUST

Position seat for optimum eye reference.

WARNING: Do not place objects between the seat and the aisle stand.
Injury can occur when the seat is adjusted forward.

Rudder Pedals (Flow) ADJUST

Adjust to permit full rudder pedal and brake application.

Right Seat Belt And Shoulder Harness (Flow) ADJUST

Accomplish RECEIVING AIRCRAFT checklist on Captain's command.

INTENTIONALLY LEFT BLANK

CAPTAIN PROCEDURE

Normally, the captain accomplishes this procedure. However, it does not preclude the First Officer from completing the procedure if time and conditions dictate.

F/O Challenge**Capt. Respond**

Left EFIS Control Panel (Flow)SET

Mins Reference And Mins Selectors (Flow).....AS DESIRED

Flight Path Vector Switch (Flow)AS DESIRED

Meters Switch (Flow)AS REQUIRED

Baro Reference And Baro Selectors (Flow)SET

Set the local altimeter setting on the PFD.

VOR/ADF Switches (Flow)AS DESIRED

ND Mode Selector (Flow)MAP

ND Center Switch (Flow)AS DESIRED

ND Range Selector (Flow)AS DESIRED

ND Traffic Switch (Flow)ON

Verify TCAS OFF indication on ND

Map Switches (Flow).....AS DESIRED

MCPSET

Left Flight Director Switch (Flow)ON

LNAV Switch (Flow).....PUSH/AS REQUIRED

Arm LNAV.

VNAV Switch (Flow)PUSH

Arm VNAV.

Initial Heading (Flow).....SET

Initial Altitude (Flow)SET

Autothrottle Arm Switches (Flow)..... ARM

Autopilot Disengage Bar (Flow) UP

Heading/Track Reference Switch (Flow)HDG

Bank Limit Selector (Flow)	AUTO
Vert Speed/FPA Reference Switch (Flow)	VERT SPEED
Altitude Increment Selector (Flow)	AS DESIRED
Left Oxygen Mask Panel	CHECKED AND SET
Mask (Flow)	STOWED
Verify doors closed.	
Reset/Test Switch (Flow)	PUSH AND HOLD
The yellow cross appears momentarily in the flow indicator.	
Reset/Test Switch (Flow)	RELEASE
Verify the yellow cross no longer appears in the flow indicator.	
Normal/100% Switch (Flow)	100%
Window 2 Left	CHECK
Verify the lock lever is in the locked (forward) position and the orange indicator is not in view.	
Map Light Control (Flow)	AS DESIRED
Captain's Heaters (Flow)	Set
Shoulder Control And Foot Selector (Flow)	AS DESIRED
Captain's Forward Panel Brightness Controls	SET
Display Brightness And Fwd Light Controls (Flow)	MID POSITION
Captain's Side Display Control (Flow)	AS DESIRED
Left Instrument Source Select Panel	SET
Navigation Source Switch (Flow)	OFF
Display Control Source Switch (Flow)	OFF
Air Data/Attitude Source Switch (Flow)	OFF
Left Clock	SET
Time/Date Selector (Flow)	UTC

Left PFD..... CHECK

Flight Mode Annunciation (Flow)..... VERIFY:

- Autothrottle mode is blank
- Roll mode is TO/GA
- Pitch mode is TO/GA
- AFDS status is FLT DIR
- Verify steering bars. (Roll centered and pitch +8 degrees.)

Left ND (Flow) CHECK

Verify map mode displayed.

Left Inboard Display Selector (Flow)..... MFD

Heading Reference Switch (Flow)..... NORM

Standby Instruments (Flow) CHECK

Attitude Indicator (Flow) CHECK

Verify no flags displayed.

Airspeed Indicator (Flow) CHECK

Verify no flags displayed. Set $V_{ref} 30 + 80$ knots on the airspeed bug.
(Do not use the Max Angle speed.)

Altimeter (Flow) SET

Set local altimeter setting.

Verify no flags displayed.

Alternate Pitch Trim Levers (Flow)..... NEUTRAL

Speedbrake Lever (Flow)..... DOWN

Reverse Thrust Levers (Flow)..... DOWN

Thrust Levers (Flow)..... CLOSED

Parking Brake..... SET

Verify **PARKING BRAKE SET** message displayed on EICAS.

Caution: Accumulator pressure may be insufficient to prevent aircraft from moving. If brake accumulator pressure is at or below 1000 psi call maintenance.

Stab Cutout Switches (Flow) NORM (GUARDED POSITION)

Fuel Control Switches CUTOFF

Verify fire warning lights extinguished.

Left Radio Tuning Panel (Flow)	SET
Pnl Off Light (Flow)	EXTINGUISHED
Set Panel (Flow)	AS DESIRED
Captain's Audio Control Panel (Flow)	SET
Set Panel (Flow)	AS DESIRED
Weather Radar Panel (Flow)	SET
Set Panel (Flow)	AS DESIRED
Center Radio Tuning Panel (Flow)	SET
Active Window	CHECK
Verify DATA is displayed in the ACTIVE window.	
Pnl Off Light (Flow)	EXTINGUISHED
Set Panel (Flow)	AS DESIRED
Observer's Audio Control Panel (Flow)	SET
Set Panel (Flow)	AS DESIRED
Flight Deck Door Switch (Flow)	AS DESIRED
Observer Audio Selector (Flow)	NORM
Left CDU	SET
Init Ref Key (Flow)	PUSH
Index Line Select Key (Flow)	PUSH
Ident Line Select Key (Flow)	PUSH
Ident Page (Flow)	CHECK
Verify active date current.	
Pos Init Line Select Key (Flow)	PUSH
Verify present position and time correct.	
Route Line Select Key (Flow)	PUSH
Verify flight number and route correct.	
Nav Rad Key (Flow)	PUSH
Verify navigation radios are set.	

Left Flight Instruments (Flow)SET

PFD (Flow)CORRECT

- Flight instrument indications are correct.
- The **NO V SPD** flag is displayed until V speeds are selected.
- Verify that no other flags displayed.

Altimeter.....SET

ND (Flow)CORRECT

Verify no flags displayed. Route displayed correctly.

Left Seat (Flow).....ADJUST

Position seat for optimum eye reference.

WARNING: Do not place objects between the seat and the aisle stand.
Injury can occur when the seat is adjusted forward.

Rudder Pedals (Flow).....ADJUST

Adjust to permit full rudder pedal and brake application.

Left Seat Belt And Shoulder Harness (Flow).....ADJUST

Crew Baggage (Flow)IDENTIFIED & SECURED

Log Book / ETOPSCHECKED, ON BOARD

Review the aircraft logbook. Ensure all discrepancies and the ETOPS Pre-Departure check (when applicable), are signed off.

Flight Attendant & Pilot Briefings.....COMPLETE


Briefings in General

Flight Attendant and Pilot Briefings are the perfect opportunity for the Captain and crew to establish a positive, professional tone for the duration of the trip. They allow the Captain to share expectations of how the team should work together to insure a safe, successful trip. Effective communications by flight deck and cabin crews are essential during normal conditions, and are absolutely critical in non-normal situations. The corporate success of our airline relies on the ability of our flight and cabin crews to convey a positive, confident atmosphere. Describing and sensationalizing potential life threatening scenarios during any briefing is neither effective nor productive, and only succeeds in creating an impression of fear and uncertainty.

Flight Attendant Briefing

The Captain will conduct a Flight Attendant Briefing prior to the first leg of the trip series or when there is a change in cabin crew. For subsequent flight legs with the same cabin crew, the briefing is normally abbreviated to include only the appropriate specifics of the flight leg. These are reflected by blue and black colored items on the guide. Flight Attendant A will introduce herself / himself to the Captain and coordinate the time and location of the initial briefing. The briefing should normally be conducted with the entire crew, including all pilots if possible. In the event that a briefing with the entire crew at the beginning of a pairing / cabin crew change is not possible, the Captain will brief Flight Attendant A, who will repeat the briefing to all other flights attendants. A briefing with the entire crew should occur at the first available opportunity. Unless there are a number of unique or significant issues, the “first leg of the trip” briefing can normally be accomplished in 2-3 minutes and the subsequent flight leg briefings in 1-2 minutes.

The following **FLIGHT ATTENDANT BRIEFING** guide and explanation provides a list of items that should be considered for review. The objective is to provide the cabin crew with concise, factual information relative to the trip / flight, and to highlight certain areas of importance. The briefing should be predicated on the assumption that the cabin crew is well versed in standard operating procedures, and as such, a comment of “Standard Operating Procedures or SOP” is appropriate for those routine items that do not require further amplification. If any item is “not applicable” or is “not an issue,” then it need not be specifically addressed in the briefing. By the same token, there may be additional special issues for the flight that, though not specifically listed, should nevertheless be addressed.

**Continental Airlines**
FLIGHT ATTENDANT BRIEFING

- Introduce Flight Crew
- Flight Time
- Life Vest Briefing As Req'd
- WX & Turbulence
- Aircraft & Cabin Logbook Items
- Cabin Preflight & Security Inspection
- Ready for Pushback / Pax Count
- Cabin Ready For T/O & Ldg
- RTO & Evac Coordination
- Sterile Light
- Flight Deck Entry Procedures
- Security or Unusual Incidents
- Questions / Additional Info From F/As

Blue items briefed at beginning of trip or F/A change
Black items briefed as required for each flight leg

Introduce Flight Crew

The Captain should introduce him / herself to the cabin crew, and if possible introduce the rest of the flight crew, including any known ACM / jumpseat riders.

- **Flight Time**

Review the planned flight time, any anticipated ground / flight delays and any possibility of a short taxi time as it may relate to timing of the passenger safety briefing.

- **Life Vest Briefing As Required**

For aircraft not equipped with automated passenger video systems (or if the system is inoperative) advise the cabin crew when the route of flight is more than 50 NM from the nearest shoreline to ensure the mandatory passenger briefing of overwater emergency equipment is accomplished.

- **Weather & Turbulence**

Review the anticipated destination weather in addition to any pertinent weather or turbulence issues for the flight. If it is expected that the departure weather will require the flight attendants to remain seated after takeoff, this is an excellent time to brief the expected duration before resumption of normal duties.

- **Aircraft & Cabin Logbook Items**

Review any aircraft or cabin logbook inoperative equipment that would have an impact on the cabin staff or services, including cabin emergency equipment, galley furnishings, lavatories, cabin ventilation issues (such as inop pack or APU), etc. Also confirm that Flight Attendant A will coordinate with the Captain regarding any cabin logbook entries, preferably before the beginning of the descent.

- **Cabin Preflight & Security Inspection**

As per SOP Flight Attendant A should inform the Captain when the cabin preflight inspection (and security inspection if required) have been completed, including confirmation of all required water and lavatory servicing.

- **Ready for Pushback / Passenger Count**

Ensure that Flight Attendant A will confirm when the cabin is ready for pushback and will also provide a final passenger count to the flight deck as soon as possible.

- Cabin Ready For Takeoff & Landing

Both takeoff and landing will be proceeded by the “standard announcement.” Flight Attendant A should promptly respond, with the “cabin ready” signal on aircraft so equipped. On all aircraft, if the cabin is not prepared for whatever reason, immediately communicate with the flight deck so that appropriate action can be taken.

- Rejected Takeoff & Evacuation Coordination

As per SOP, in the event of a rejected takeoff or a non-normal landing, you can expect the flight deck will give the PA command “REMAIN SEATED, REMAIN SEATED” as soon as possible. Keep the passengers seated and calm while evaluating your assigned exit door window. As soon as the flight crew is able, they will make an appropriate announcement, explaining what the course of action will be. If you observed something inside or outside the aircraft that is of **obvious danger**, relay the information to the flight deck. If contact with the flight deck is not possible, signal with 4 chimes and if absolutely necessary, initiate an evacuation.

- Sterile Light

Brief any deviations from SOP regarding the **STERILE LIGHT** due to equipment or unique operational issues. Recall that communicating a valid safety of flight issue takes priority over an illuminated **STERILE LIGHT**.

- Flight Deck Entry Procedures

Emphasize the necessity for **everyone** desiring access to identify themselves on the interphone and keeping the flight deck door open only long enough for prompt transit of authorized individuals or articles.

- Security or Unusual Incidents

Appropriate security information and any unique security measures for the specific flight should be shared, including the presence of FAMs, LEOs, etc. The flight attendants should advise the flight deck of all security incidents or other unusual problems. *Effective communications between the cabin and flight deck are paramount.* All crewmembers should refer to the ONBOARD SECURITY INCIDENT guide for individual responsibilities during a security incident.

- Questions or Additional Information From Flight Attendants

Address any questions or open issues and ask if the flight attendants have any additional information for the flight crew. Have any assigned FAMs provide their briefing.

Pilot and Departure Briefing

The Captain will conduct a Pilot Briefing including the **CRM** and **Departure** sections with the entire flight deck crew prior to the first leg of the trip series or when there is a change in pilots. For subsequent flight legs with the same crew, the **CRM** items do not need to be repeated unless there are changes, and only those items associated with the specific **Departure** or **Arrival** need be addressed. These are reflected by blue and black colored items on the guide. Unless there are a number of unique or significant issues, the “first leg of the trip” briefing can normally be accomplished in 3-4 minutes and the subsequent flight leg briefings in 2-3 minutes. This briefing should be accomplished at the gate prior to push / start so that the entire crew can collectively review the plan as opposed to trying to conduct a complete briefing during taxi or just prior to takeoff. If there are subsequent changes from what was briefed, such as runway changes, SIDS, automation modes, etc., those items should be reviewed at an appropriate time consistent with workload and preferably with the aircraft stopped.

The following **PILOT BRIEFING** guide provides a list of items that should be considered for review. The objective is to provide the crew with concise, factual information relative to the trip / flight, and to highlight certain areas of importance. The briefing should be predicated on the assumption that flight crewmembers are well versed, in standard operating procedures and as such, a comment of “Standard” or “SOP” is appropriate for those routine items that do not require further amplification. If any item is “not applicable” or is “not an issue,” then it need not be specifically addressed in the briefing. By the same token, there may be additional special issues for the flight that, though not specifically listed, should nevertheless be addressed. The pilot who will be flying the departure should brief those items associated with the procedure as defined by the **PILOT FLYING BRIEFS** items. Note items shown in gray color are not applicable to the **Departure** briefing.



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PILOT BRIEFING

CRM

- Experience Level, Currency
- PF, PM, IRO Duties, Threat-Err Mgt

Departure or Arrival

- MEL, NOTAMs, Unique Issues
- Arpt Info (-7) & Taxi Plan (-9)
- WX, Rwy Cond, T/O or Ldg Wt
- RTO & Evac Issues
- Air Return, Fuel Jett, Altn
- **TERR** Considerations

PILOT FLYING BRIEFS

- SID or STAR & Approach
- Displays & Automation Modes
- Trans -ALT_(dep) -LVL_(arr)
- EO Spl Procedures / Accel Alt

ACM, Enrte Issues, PAs, Questions

Blue items briefed at beginning of trip or pilot change
 Black items briefed as required for each flight leg

CRM

- Experience Level / Currency

A review of any significant experience level on the aircraft (such as low time in type restrictions) and any currency issues, including last takeoff / landing, extended time off, different seat position, etc.

- PF, PM, IRO Duties and Threat-Error Management

A review of any duties that are non-routine in nature or if they are to be performed by other than the normal seat position, such as IOE, ferry / test flights, a Captain assigned to the F/O seat, etc. Use of Standard Operating Procedures (SOP) and proven Threat-Error Management techniques should be emphasized.

Departure

- MEL, NOTAMs, Unique Issues

Review any inoperative or MEL'd aircraft components, any NOTAMs that have an operational impact, and any other unique operational issues. These may include items such as airport curfews, charter / ferry issues, maintenance verification / test flight requirements, crew legality, security issues, and any other factor that may effect the departure phase of the flight.

- Airport Information (-7 page) and Taxi Plan (-9 page)

A comprehensive review of all general information on the -7 page(s) in addition to the appropriate DEPARTURE CONSIDERATIONS block. Review as necessary the anticipated taxi plan for departure including the route, planned runway entrance points, parallel runways operations, taxiway restrictions for size or weight, and gate / pushback procedures.

- Weather / Runway Conditions / Takeoff Weight

A review of current weather for departure including considerations for adverse weather operations such as deicing procedures, necessity of engine / wing anti-ice, low altimeter, windshear, etc. Additionally review the planned runway, wind considerations, any braking action reports or performance limitation / penalties, and anticipated takeoff weight.

- Reject Take Off & Evacuation Issues

Review rejected takeoff considerations and crew evacuation duties if other than SOP due to runway issues, inoperative components, or unique crew compliment.

- Air Return / Fuel Jettison / Alternate

Review the plan for an immediate air return, including estimated landing weight, performance limitations, and approximate amount and time for fuel jettison if applicable. If applicable, review the takeoff alternate details, including weather, approximate distance, and time.

- Considerations

WARNING: Prior to departure at airports near mountainous or significant terrain the following procedures will be accomplished:

- All appropriate SIDS, STARS, approach charts, ENGINE FAILURE ON DEPARTURE / ONE ENGINE INOPERATIVE MISSED APPROACH procedures, and associated enroute charts for the departure and arrival will be reviewed and readily available.
 - The flight crew will review all Grid MORAs, MEAs, MOCAs, AMAs to include position of high terrain along the departure / arrival route.
 - For aircraft with enhanced GPWS, at least one pilot will have the TERR function selected. This feature should be considered for use even in day VMC conditions in order to assist in building a mental picture of the airport and surrounding terrain. If this feature is not installed, consider using radar to help identify prominent terrain features.
- SID or STAR & Approach Review (**PILOT FLYING BRIEFS**)

Review the departure procedure and confirm correct FMC programming for airspeeds, altitudes, routing, etc. This should normally be briefed by the pilot who will be flying the procedure.
 - Displays & Automation Modes (**PILOT FLYING BRIEFS**)

Ensure the navigation display options selected are appropriate for the procedure and phase of flight, including scale, radar / TCAS / nav aid information displayed, and raw data as required. Review the automation modes to be used during the procedure (LNAV, VNAV, A/P and A/T off/on, etc).
 - Transition -ALTitude (departure) (**PILOT FLYING BRIEFS**)

Review the Jepp chart and cross check the FMC TRANS ALT value on the FMS CLB page (as installed) for departure.

- Engine Out Special Procedures / Acceleration Altitude-Height (**PILOT FLYING BRIEFS**)

Review the specific –7 pages and procedures for ENGINE FAILURE ON DEPARTURE / ONE ENGINE INOPERATIVE MISSED APPROACH and program the FMC as required. Some airports have FMC EO “pop-up” SIDS that should temporarily be selected (*but not executed*) during preflight to visually review the track and procedure.

Additional Crew Members, Enroute Issues, Public Addresses, Questions

Ensure ACMs / jumpseaters are familiar with the JUMPSEAT RIDER BRIEFING GUIDE, safety equipment, oxygen system, and security procedures. Review any significant enroute issues and establish who will accomplish PAs. Ensure any questions or open issues are addressed and that the flight crew is in agreement with the plan for safe and efficient conduct of the flight.

Call for RECEIVING Checklist.

VNAV OPERATION - PREFLIGHT**MCP PREFLIGHT**

If operational, VNAV should be used for all takeoffs. Press the VNAV switch on the MCP and verify that VNAV is armed on the FMA.

Note: If the PERF INIT page is not complete (all boxed prompts loaded) when VNAV is armed, the EICAS advisory **FMC MESSAGE** is displayed and the CDU message (**MSG**) light illuminates indicating the CDU scratch pad message **PERF/VNAV UNAVAILABLE**. Clear the message.

CDU PREFLIGHT

All boxed prompts on the PERF INIT page (ZFW, CRZ ALT, COST INDEX) must be loaded for VNAV to function.

Note: To create the path for VNAV there must be a cruise altitude (entered on PERF INIT, CLB, or CRZ pages) and an end of descent point (created by selecting an arrival/approach on DEP/ARR page).

Verify EO ACCEL HT, ACCEL HT, and THR REDUCTION altitudes on TAKEOFF page 2/2 are correct.

Verify/enter the climb, cruise, and descent speeds on the three VNAV pages:

- Page 1/3 – ACT 250KT CLB – normally use ECON speed.
- Page 2/3 – ACT ECON CRZ – use the flight plan speed.
- Page 3/3 – ACT ECON DES – use the flight plan speed.

If desired, and the PERF INIT page is complete, a speed and altitude restriction may be entered on the SPD RESTR line on the ACT 250KT CLB page. Do not enter a speed of 250 Kts or greater. This deletes the FMC default SPD TRANS of 250/10000 and the aircraft accelerates to the climb speed on the ECON SPD/SEL SPD line when it climbs above the altitude entered on the SPD RESTR line.

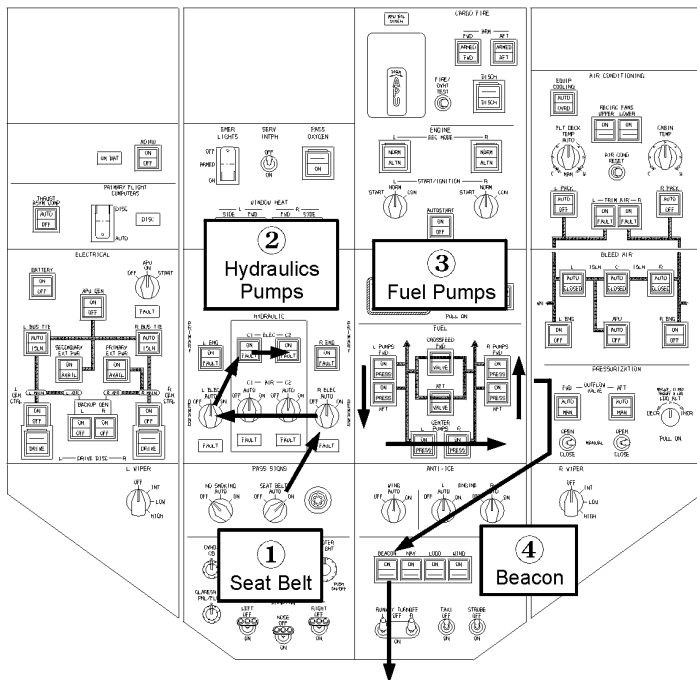
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GATE DEPARTURE PROCEDURES

General

Approximately five minutes prior to departure, the ground crew will coordinate the proposed engine start time with the flight crew. At this time, the parking brake should be set and wheel chocks removed. The headset operator is responsible for verifying that all personnel are clear of the aircraft. In addition he will check that all doors and service panels are properly closed and that the wing tip markers (if installed) are removed. The headset operator should then state: "WALKAROUND COMPLETE. ALL DOORS AND ACCESS PANELS SECURE." The headset operator should also state "READY FOR PUSHBACK" or "CLEARED FOR ENGINE START."

BEFORE START FLOW



Captain's Flow

- ① Flight Controls CHECK

⑤ Trim

First Officer's Flow

- ① Seat Belt ON
- ② Hydraulics Pumps AUTO/ON
- ③ Fuel Pumps ON
- ④ Beacon ON
- ⑤ Trim Set

BEFORE START

The BEFORE START flow will be initiated when the Captain calls for the checklist.

The Captain will call for the BEFORE START checklist after:

- All cabin doors are closed
- All passengers are seated
- All carry-on luggage is properly stowed

If a pushback is required, the checklist will be completed prior to aircraft movement. In the event a pushback is not required, the checklist will be completed prior to engine start.

When engine start clearance is received, the Captain will call for the appropriate engine to be started.

F/O Challenge	BEFORE START	Capt. Respond
Cockpit Windows	CLOSED & LOCKED (F, C)	
Seat Belt Sign.....	ON	
Hydraulic Pumps	ON/AUTO	
Fuel.....	____ REL, ____ ON BOARD	
Fuel Pumps.....	ON	
Beacon.....	ON	
MCP.....	SET	
CDU/Reference Speeds.....	SET (F, C)	
Trim	____ UNITS, ZERO, ZERO	
Flight Controls.....	CHECKED	
Doors	AUTO (F, C)	

F/O Challenge**Captain Respond**

Seat Belts (Flow) ON (F, C)

Each flight crewmember shall keep their **seat belt** fastened when at their station and the aircraft is moving.

Cockpit Windows.....CLOSED & LOCKED (F, C)

Verify the window crank is full forward to the stop, window not closed placard not in view, lock lever in forward position, and locked / unlocked indicator indicates locked.

Seat Belt Sign ON

Hydraulic Pumps..... ON/AUTO

Note: Right demand pump selector **MUST** be placed in the **AUTO** position first, pressurizing the right system. Failure to pressurize the right system first **WILL** transfer hydraulic fluid from the center system into the right system causing an overfill (OF).

Right Demand Pump Selector (Flow)..... AUTO

Verify **FAULT** light extinguished.

C2, C1 And Left Demand Pump Selectors (Flow) AUTO

Verify **FAULT** lights extinguished.

C1 And C2 Primary Pump Switches (Flow) ON

All electric and air driven hydraulic pump switches are turned **AUTO/ON**. Engine pump switches are left **ON**.

Verify **FAULT** lights extinguished.

Fuel..... REL, ON BOARD

Check the fuel on board against the dispatch release **GATE FUEL**, fuel slip, and weight and balance for agreement. (If the value is less than **GATE FUEL** ensure at least **MIN FUEL** plus **TAXI** aboard.) Any irregular load/distribution of fuel should be investigated. Ensure the wing fuel tanks are balanced. Check that all required fuel documentation is on board.

Fuel Pumps..... ON

Left And Right Fuel Pump Switches (Flow) ON

Verify **PRESS** lights extinguished.

IF Center Tank Contains Fuel:

Center Fuel Pump Switches (Flow) ON

Verify **PRESS** lights extinguished.

Note: One **PRESS** light may not be extinguished due to load shedding. Indications will be normal after engine start.

Beacon ON

MCP SET

IAS/Mach Selector (Flow) SET

Set **V₂** speed in the **IAS/MACH** window.

LNAV Switch (Flow)..... CHECK

LNAV if required.

VNAV Switch (Flow) CHECK

Verify VNAV is armed.

Initial Heading (Flow)..... CHECK

Initial Altitude (Flow) CHECK

CDU/Reference Speeds SET (F, C)

Init Ref Key (Flow) PUSH

Verify fuel quantities agree:

- Upload fuel quantity
- EICAS
- CDU

Check / Enter:

- Zero fuel weight
- Reserve fuel
- Cruise altitude
- Cost index

Thrust Lim Line Select Key (Flow) PUSH

Select takeoff thrust:

- Full thrust
- Assumed temperature derate.

Select climb thrust.

Takeoff Line Select Key (Flow)..... PUSH

Next Page Key (Flow)..... PUSH

Check / Enter:

- Surface wind
- Runway wind component
- Engine out acceleration height
- Acceleration height
- Thrust reduction point.

Previous Page Key (Flow)..... PUSH

Check / Enter:

- Enter takeoff flap setting.
- Check assumed temperature.
- Enter CG.
- Check runway position value.
- Select or enter takeoff speeds.

Trim..... UNITS, ZERO, ZERO

Set stabilizer trim per Accuload data. Verify aileron trim and rudder trim are set at zero.

Flight Controls CHECKED

Select the FCTL synoptic on the Captains MFD.
Captain will fully displace rudder, control wheel, and control column in both directions while verifying proper flight control movement on FCTL synoptic display as depicted in Section 6.9, Flight Controls. When the control check is complete, the Captain will select the MFD to the ND position.

Note: Hold the nose wheel steering tiller stationary during rudder check to prevent nose wheel movement.

Doors AUTO (F, C)

Select the Doors synoptic on the F/O's MFD. Use of the synoptic will assist the Captain in determining when aircraft movement is imminent. The crew must confirm that all doors are closed and all passenger entry doors are in the auto mode prior to aircraft movement or engine start.

PUSHBACK / TOW OUT PROCEDURE

This procedure is required when the aircraft is to be pushed back or towed away from the terminal or loading area. Flight interphone contact with ground crew must be established. Engine start is authorized during pushback.

Note: Powerback procedures are not authorized.

Note: Pushback or tow out is normally accomplished with all hydraulic systems pressurized and the nose gear steering lockout pin installed. In this configuration, the Captain can complete an operational check of the rudder pedals as part of the flight control check. When displacing the rudder pedals to their full travel, the Captain should keep the nosewheel steering handle centered.

Note: Engines on the B777 will not be started on pushback under any circumstances unless the ramp is in a dry condition. An exception would be allowable when the aircraft APU is inoperative.

After tow tractor and tow bar have been connected and clearance obtained, give push-out signal to tractor operator. Headset operator must accompany tractor and aircraft during push-out to observe for possible safety hazards. Tractor operator is responsible to observe headset operator and aircraft for signals or possible safety hazards. After tractor and tow bar are clear of aircraft, proceed as described in the Taxi-Out procedure.

When Cleared for Pushback / Tow Out:

Parking BrakesOFF

When Pushback / Tow Out is Complete:

Parking Brakes SET

Tow Bar.....DISCONNECTED

Clearance From Ground Crew.....TUG & TOW BAR CLEAR

Nose Gear Steering Lockout PinREMOVED

Interphone (After Engine Start Procedure Complete).....REMOVED

INTENTIONALLY LEFT BLANK

ENGINE AUTO START PROCEDURE

CAPTAIN	FIRST OFFICER
Announce engine start sequence. Normal starting sequence is L, R.	Display secondary engine indications on lower center MFD.
Announce "START ___ ENGINE"	Position ___ START/IGNITION selector to START
Position FUEL CONTROL switch to RUN	
Caution: Observe oil pressure increase. Auto Start does not monitor oil pressure or oil temperature. Abort start if no oil pressure or high oil temperature is observed after initial EGT rise.	

Repeat procedure to start remaining engine.

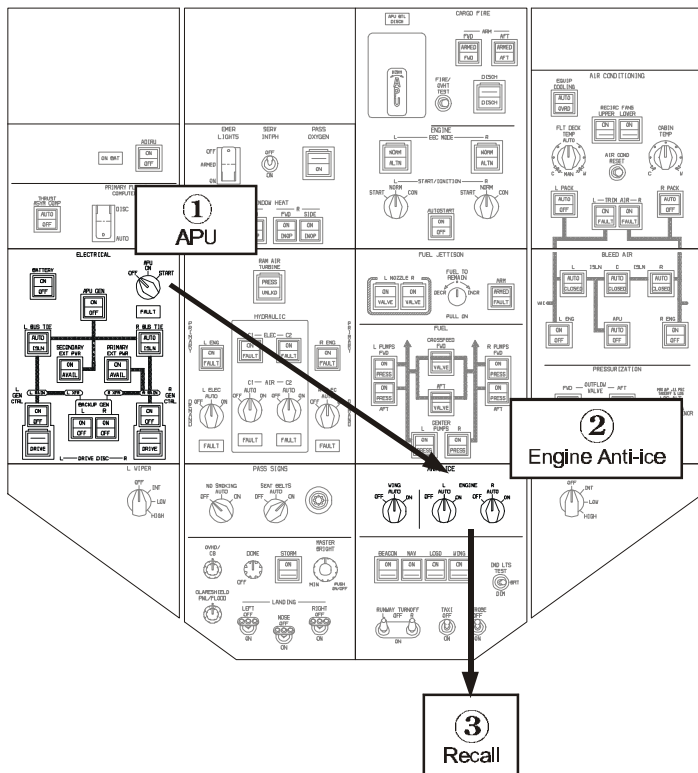
Note: Autostart takes corrective action for the following non-normal conditions:

- | | |
|--|---|
| <ul style="list-style-type: none"> • No EGT rise • Hot start • Hung start • Compressor stall | <ul style="list-style-type: none"> • No N1 rotation • Insufficient air pressure for starter operation • Start time exceeds the starter duty cycle timer • Starter shaft failure |
|--|---|

If an autostart off procedure is required refer to the Engine Manual Start procedure listed in the UNANNUNCIATED sub-section of Section 2 Non-Normal.

Caution: Be aware that electrical power interruptions, on the ground, can create a situation where Autostart will not protect the engine from a hot start.

AFTER START FLOW



Captain's Flow

- 1 Flight Deck Door CLOSED & LOCKED
2 Radio Panel ATC

First Officer's Flow

- ① APU OFF
(At Captain's direction)
- ② Engine Anti-ice AUTO/ON
(As required by conditions)
- ③ Recall Check

AFTER START

The AFTER START flow will be initiated when the Captain calls for the checklist.

The Captain will call for the AFTER START checklist after the engine(s) have reached a stabilized idle and the headset operator has been cleared to disconnect.

The AFTER START checklist will be completed prior to releasing the brakes for taxi.

F/O Challenge	AFTER START	Capt. Respond
Engine Anti-Ice.....		(AS REQUIRED)
Recall.....		CHECKED
Autobrake.....		RTO
Flaps		SET ____
Flight Deck Door		CLOSED & LOCKED

FIRST OFFICER PROCEDURE

F/O Challenge

Captain Respond

APU Selector (Flow)(AS REQUIRED)

The Captain will advise if the APU is required for operational reasons.

Engine Anti-Ice(AS REQUIRED)

When icing conditions exist or are anticipated, as each engine is started position the respective engine anti-ice switch ON.

Recall.....CHECKED

If any messages displayed refer to the MEL and/or DDP to determine if dispatch relief is available.

Autobrake.....RTO

If operational, the autobrake will be verified to be in the RTO selection for all takeoffs.

Flaps SET ____

This item of the checklist is a read and do item. The First Officer should not set the flaps until commanded to by the Captain at this point in the checklist. The Captain's response to the challenge Flaps is the order to select the flap lever to the desired flap setting. Both pilots should verify the flap lever is set as commanded and the flaps begin to move to the selected position before the checklist is announced complete. (The crew should not wait for the flaps to reach the commanded position prior to taxi. Actual flap position will be verified during the BEFORE TAKEOFF checklist.)

CAPTAIN PROCEDURE

F/O Challenge

Captain Respond

Radio Panel (Flow) SET

Select VHF L on the left audio selector panel.

Flaps SET ____

Flight Deck Door.....CLOSED & LOCKED

Flight deck doors must be closed and locked from the *beginning of the aircraft moving under its own power until block in*, with the exception of transit by authorized personnel. **It is imperative that the flight deck door be open only long enough for expeditious transit of authorized individuals or items.** Do not allow the door to remain open for extended periods of time for any reason.

All individuals (including pilots, flight attendants, ACM / jumpseat riders, etc.) desiring access to the flight deck for entrance or for transit of items must comply with the following procedures:

1. Ensure the immediate area around the flight deck door (and ideally the forward lavatory(s) on aircraft so equipped) is clear of customers.
2. Identify yourself to the flight crew via the interphone, to include name and, if necessary, employee number. It is appropriate for the flight deck crew to have access to the assigned crew list in the event there is any question as to the identity of someone requesting access. This is especially true with large crew compliments where the flight deck is not likely to recall all crew names or recognize voices. For ACMs / jumpseat riders who may not be familiar with the interphone system (such as FAA inspectors, ATC personnel, etc.) a flight attendant will assist in placing the interphone call and confirming the individual's identity. Any individual not part of the working crew must wear

their identification in a clear and visible manner while entering, leaving, or on the flight deck. **Do not call until ready for access / entry.** Do not request entry and then wait an extended period of time before arriving at the door. Whoever makes the call is responsible for ensuring that no unauthorized individuals are allowed access.

3. **Firmly knock 2 times** on the flight deck door. The flight crew will lift the coverguard and hold down the red UNLOCK switch located on the door control panel until the door is opened. If the flight crew has any reservations as to who has knocked, they must visually confirm the identity of the individual via the door viewing port before unlocking. While the door is open, the amber **OPEN** light on the door control panel is illuminated to serve as reminder to keep the door open time to an absolute minimum.
4. Anyone exiting the flight deck should first look through the viewing port to check the area outside the door. If possible, exit when there are no customers near the door area. The door is normally opened by rotating the doorknob in either direction. It is the responsibility of the individual opening the door to close the door immediately after transit.

Note: Anytime the aircraft is operating on normal electrical power the door will automatically lock when it is closed.

If the door does not electrically lock after closing, or if there is an internal system failure, the red **UNLKD** light illuminates. The crew must investigate the problem and take corrective action, including use of the mechanical lock pin if necessary, to secure the door.

5. The door must be left open by the flight crew when departing the aircraft after the flight. If the door is inadvertently closed (and therefore automatically locked) either a pilot or maintenance technician may use the FLIGHT DECK EMERGENCY ENTRANCE system to gain access.

TAXI

Once the AFTER START checklist is complete, and the Captain is confident that the area around the aircraft is clear, the Captain will call "TAXI CLEARANCE." The First Officer will obtain a taxi clearance.

The Captain will confirm the taxi instructions by verbally repeating the instructions to the First Officer.

There is a large area near the aircraft where personnel, obstacles or guidelines on the ground cannot be seen, particularly in the oblique view across the flight deck. Special care must be exercised in the parking area and while taxiing. When parked, the pilot should rely on ground crew communications to a greater extent to ensure a safe, coordinated operation.

Caution: Outside vigilance during taxi is the responsibility of both pilots. Prior to the aircraft movement both pilots will verify that the aircraft is clear of all obstacles by announcing "CLEAR LEFT/CLEAR RIGHT."

TAXI-OUT

Once the headset is removed, the headset operator shall position himself between aircraft and terminal building in full view of the flight deck. This could be on the left or right side of the aircraft depending on the direction of aircraft movement.

When the Captain is ready to taxi and has received clearance to do so, he/she will indicate this to the headset operator / safety man by turning the nose gear or similar light ON.

The headset operator / safety man shall ascertain that the area is clear to taxi and the CLEAR TO TAXI salute shall be given to the flight deck. The Captain will acknowledge receipt of this salute by turning the nose gear or similar light OFF. As the aircraft departs, the headset operator / safety man will give the END OF GROUND GUIDANCE signal.

Note: In order to avoid confusion during night operations, the Captain should leave the taxi light off for 1-2 seconds before turning it back on for use during taxi operations.

Note: The aircraft will not be taxied away from a gate (or pushback position), unless the marshaller gives the crew the proper signal that the aircraft is cleared to taxi. Should, for some reason, the marshaller not be visible, or leave his/her position on the ramp, the aircraft will not taxi. Call the station on company radio and have the marshaller return and give taxi clearance.

Note: The headset operator is responsible to ensure the aircraft, personnel and equipment are clear from injury or damage from jet blast before taxi-out signals are given aircraft. High lift trucks at gates immediately behind must be lowered before aircraft taxis out

TAXI PROCEDURES

Aircraft response to thrust change is slow, particularly at high gross weights. Idle thrust is adequate for taxiing under most conditions. A slightly higher thrust setting may be required to start taxiing. Allow time for aircraft response to each thrust change.

To initiate taxi, release brakes, smoothly increase thrust to minimum required for the aircraft to roll forward, max N_1 35%, and reduce thrust to idle. Do not start a turn until sufficient forward speed has been attained to carry the aircraft through the turn at idle thrust.

Thrust use during ground operation demands sound judgment and technique. The air blast effects from the high bypass engines at relatively low thrust can be destructive and cause injury. Avoid following other aircraft too closely. Jet blast is a major cause of foreign object damage.

The tendency is to taxi faster than desired. This is especially true during runway turnoff after landing. The ND GS display may be used to determine actual taxi speed. The appropriate taxi speed will depend on turn radius and surface condition. Nose wheel scrubbing indicates excessive steering angle and/or taxi speed for surface condition. The normal straight away taxi speed should not exceed approximately 25 knots. When approaching a turn, speed should be slowed to the appropriate speed for the conditions. On a dry surface, use approximately 8 to 10 knots.

Note: Use of reverse thrust is not recommended during taxi. At low speeds, the reverse thrust can cause loose objects on the taxiway to be ingested causing FOD.

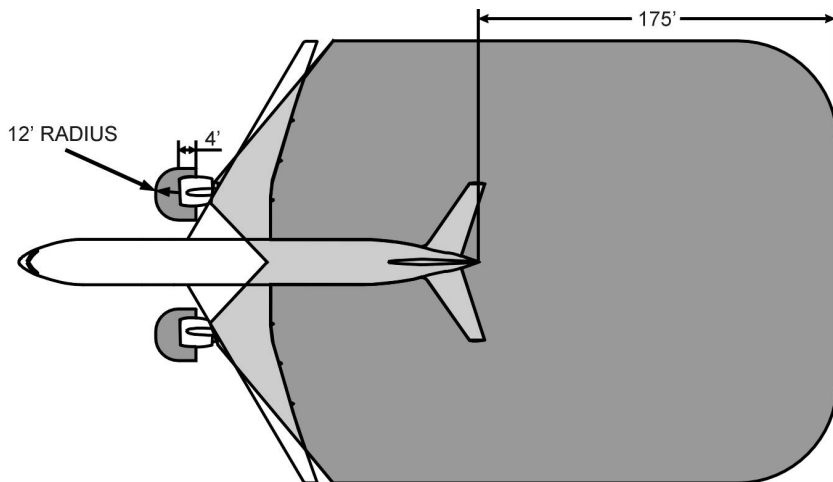
Do not be diverted from the primary task of safely taxiing the aircraft. The flight crew should avoid all unnecessary activity and duties (including paperwork) that can be accomplished at another time.

The Captain and First Officer's positions are equipped with a tiller steering control, however **only the Captain will taxi the aircraft**. The tiller performs the same function as a conventional steering wheel. Maintain a positive pressure on the tiller when entering or exiting a turn to prevent the nose wheel from abruptly returning to center. Main gear aft axle steering is installed to minimize tire scrubbing and is automatically activated when the nose gear steering angle exceeds 13 degrees.

Differential thrust may be required at heavy weights during tight turns. This should only be used as required to maintain the desired speed in the turn. After completing a turn, center the nose wheel and allow the aircraft to roll straight ahead. This will relieve stresses in the main and nose gear structure prior to stopping

Turning radius during 180 degree turns can be reduced, with lower engine thrust and less nose gear tire wear by following a few specific taxi techniques. Taxi the aircraft so that the main gear tires are as close as possible to the runway edge. This provides more runway surface to make the turn. Stop the aircraft completely with the thrust at idle. Hold the tiller to the maximum steering angle, release the brakes, then add thrust on the outboard engine. Use only the outboard engine and maintain 10 knots or less during the turn to minimize the turn radius. These actions will result in a low speed turn and less runway being used. Light intermittent brake applications on the inside of the turn will help reduce the turn radius.

Note: If any doubt exists, when making a minimum radius turn, stop the aircraft and call for a marshaller.

TAXI NOTES**Thrust Use**

IDLE THRUST

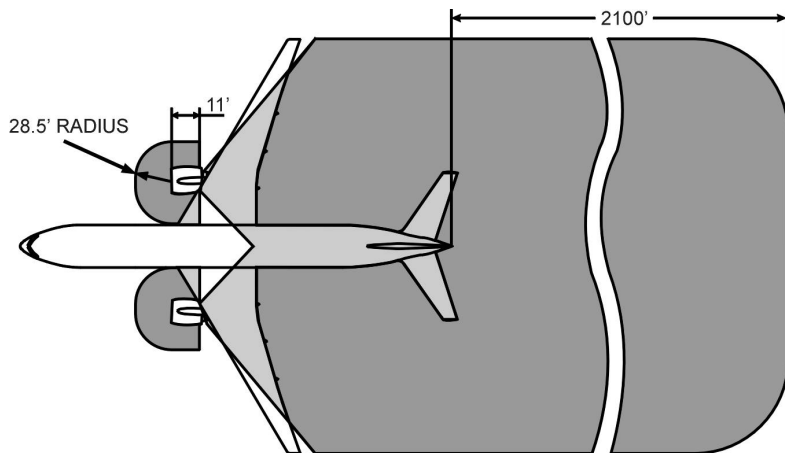
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Where there is a possibility of jet blast damage, the proper throttle technique will be:

- Advance engines to a maximum of 35% N_1 RPM.
- Retard the power as soon as possible after the aircraft starts to taxi.
- If a tight turn is required in a restricted area, leave the power on until the point where the jet blast area could cause a problem, then close throttles. This should provide sufficient momentum to sustain taxi-out of the congested area.

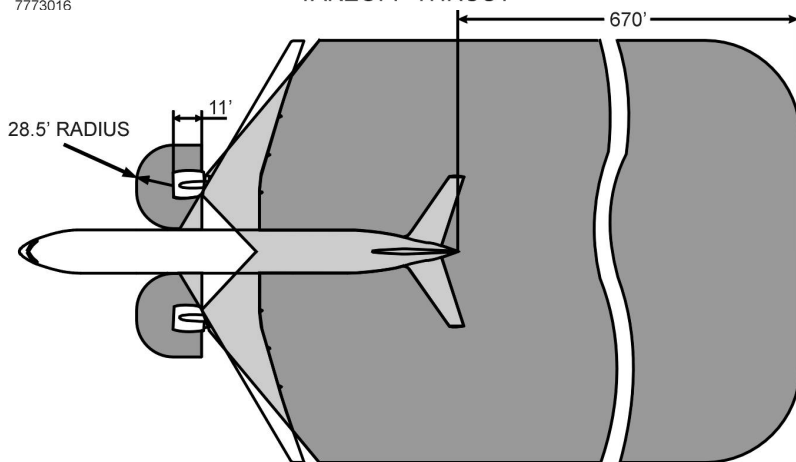
If 35% N_1 RPM will not move the aircraft in those tight gate areas where there is exposure to jet blast damage, the Captain will close the throttles and request a tow-out.

Thrust Danger Zones



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TAKEOFF THRUST



7773015

BREAKAWAY THRUST

WARNING: Keep all personnel out of danger zones during engine operation. The engine can PULL persons or unwanted materials into them and cause severe injuries to personnel or damage equipment.

If the surface wind is more than 25 knots, increase the danger zone at the engine inlet by 20%.

Rudder Trim

Rudder trim application will result in uneven rudder pedal position. Rudder pedal differential will also result in abnormal nose wheel steering control displacement during taxi and takeoff. Any significant rudder trim application on the ground should be apparent to the crew during taxi and takeoff roll.

The rudder pedal displacement caused by rudder trim can be compensated for and directional control maintained with the rudder pedals. Rudder trim does not reduce available rudder travel but will increase the pedal force required to oppose the trim.

Nosewheel / Rudder Pedal Steering

Maintain a positive pressure on the nose steering wheel in both directions to prevent the nose gear from returning to center abruptly. Straight ahead steering and large radius turns may be accomplished with rudder pedal steering only. If nose wheel “scrubbing” occurs while turning, reduce steering angle and/or taxi speed. Differential thrust may be required for heavy aircraft during tight turns, but should only be used as required to maintain the desired speed in the turn.

Center the nose wheel and allow the aircraft to roll straight ahead to relieve stress on the main and nose gear structure and oleo strut seals prior to stopping after completing a turn. Avoid stopping the airplane in a turn as excessive thrust will be required to start taxiing again.

Brakes

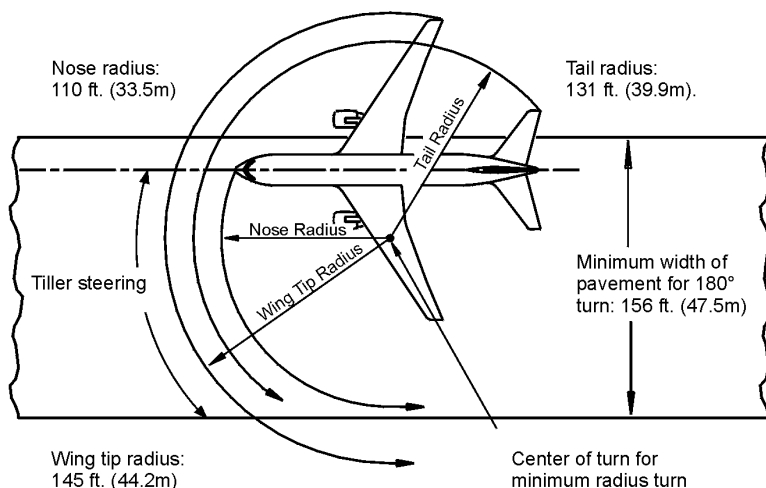
Avoid riding the brakes to control taxi speed. If taxi speed is too high, reduce speed with a steady brake application and then release the brakes to allow them to cool. Continuous braking should be avoided. Allow for decreased braking effectiveness on slick surfaces. Avoid taxi speeds greater than 30 knots on long taxi routes. Braking to approximately 10 knots and subsequent release of the brakes will result in less wear of the carbon brakes than when the brakes are constantly applied. Under normal conditions differential braking and braking while turning should be avoided. Allow for decreased braking effectiveness on slick surfaces.

Turning Radius

The following figure shows the minimum turn radius capability. The wing tip swings the largest arc while turning and determines the minimum obstruction clearance path. All other portions of the aircraft structure are within this arc.

Note: The wing tip travels outboard about 5' and travels 35' in front of the nose.

Caution: Do not attempt to make a turn away from an obstacle within 15' of the wing tip or within 51' of the nose.



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Taxiing in Reduced Visibility

Caution must be exercised when taxiing in conditions of reduced visibility. The crew should familiarize themselves with the airport taxiways, intersecting runways, and any obstructions that may be a hazard to safety. The crew should not hesitate to discontinue taxiing if any doubt exists about the aircraft's location on the field. If the Captain does stop the aircraft, the First Officer must notify ground control so that any approaching aircraft can be notified.

Outside vigilance by both crewmembers is paramount when taxiing in conditions of reduced visibility. If possible, checklist should be accomplished while the aircraft is not moving and the parking brake is set. While taxiing, utilize the Jeppesen airport diagrams to the maximum extent possible. If confusion exists, ask for clarification from ground control. When cleared for takeoff, ensure that the correct runway is being used.

Taxi in Adverse Weather

Taxi under adverse weather conditions requires more awareness of surface conditions. If the taxiways and runways are covered with snow, slush, or water, (OAT 50°F/10°C or less) consideration should be given to the use of engine anti-ice.

When taxiing on a slick surface use reduced speeds. Use of differential engine thrust will assist in maintaining aircraft momentum through the turn. Avoid using large tiller inputs to correct for skidding. Differential braking may be more effective than nose wheel steering on very slick surfaces. If speed is excessive, reduce speed prior to initiating a turn.

During cold weather operations, nose gear steering should be exercised in both directions during taxi. This will circulate warm hydraulic fluid through the steering cylinders and minimize the steering lag caused by low temperatures. If icing conditions are present, the engine anti-ice switches should be turned on immediately after engine start (auto anti-ice does not work on the ground).

During ground operation including taxi-in and taxi-out in icing conditions, the engines must be run up momentarily to a minimum of 50% N₁ at intervals not to exceed 15 minutes.

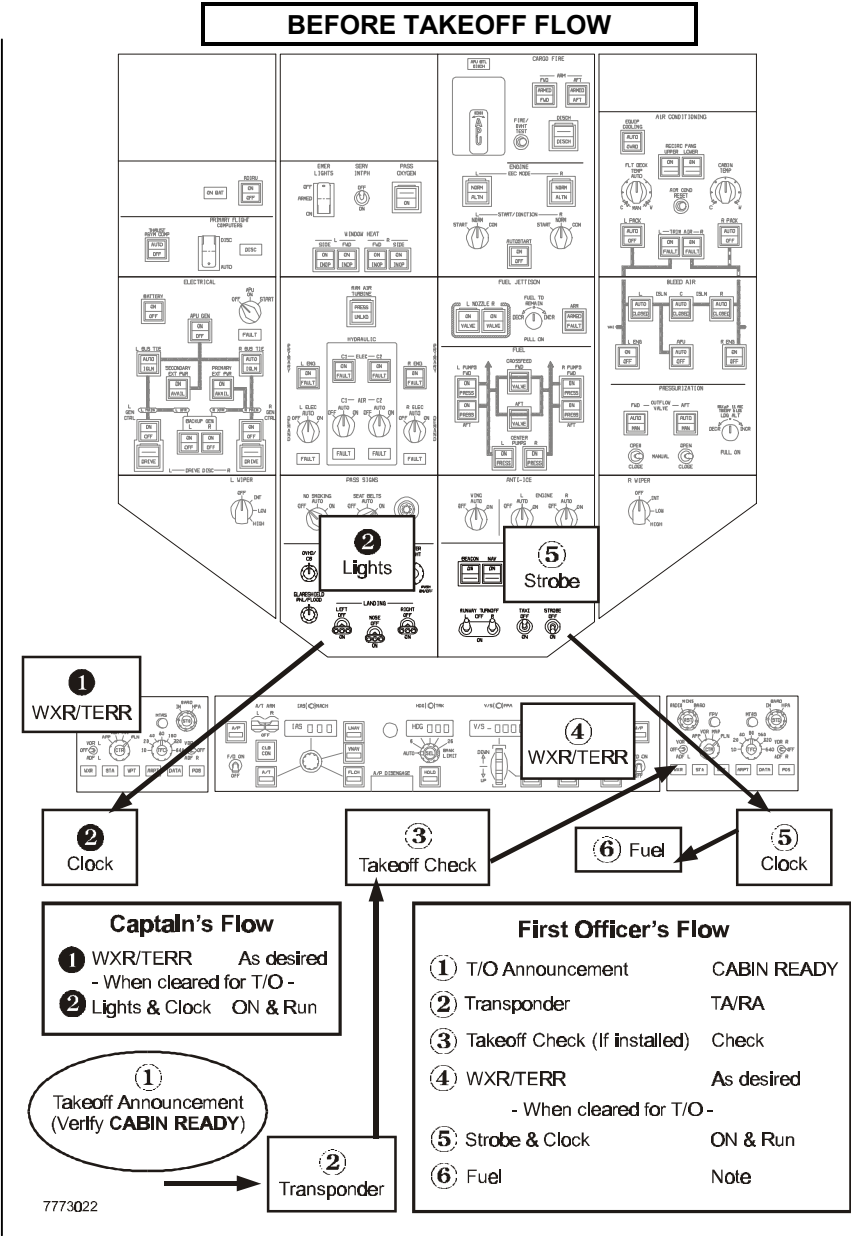
Engine exhaust may form ice on the ramp and takeoff areas of the runway, or blow snow or slush which may freeze on aircraft surfaces. If the taxi route is through slush or standing water, taxi with flaps up. Extended or prolonged taxi times in heavy snow may necessitate de-icing prior to takeoff.

To reduce the possibility of flap damage, after making an approach in icing conditions or landing on a runway covered with snow or slush do not retract the flaps until the flap area has been checked to be free of debris by maintenance.

Taxi – One Engine

Because of additional operational procedural requirements and crew workload, taxiing with an engine shut down is **not allowed**. High bypass engines require warm up prior to applying takeoff thrust and cool down prior to shutting down. If the engine has been shut down for several hours, it is desirable to operate at as low a thrust setting as practicable for several minutes prior to takeoff.

Note: Single engine taxi **with an inoperative engine** is authorized consistent with good judgement.



BEFORE TAKEOFF

The Captain will call for the BEFORE TAKEOFF checklist when cleared onto the active runway.

For both day and night operations all landing lights, runway turn off lights, and strobe lights will be turned on only after takeoff clearance is received as an indication to other traffic that your aircraft is beginning the takeoff roll.

For night operations, some auxiliary lighting in addition to the beacon and navigation lights (but not the strobe lights or the landing lights) should be turned on when taking the active runway in order to provide exterior illumination for other traffic to see the aircraft.

Meteorological conditions permitting, at the minimum the use of the landing lights and runway turnoff lights are required below 18,000 feet for both day and night operations.

F/O CHALLENGE	BEFORE TAKEOFF	F/O RESPOND
Departure Briefing		COMPLETE
Takeoff Announcement		CABIN READY
Flaps		
Takeoff Check (If Installed)		CHECKED
Transponder.....		TA/RA

F/O Challenge**F/O Respond**

Shoulder Harness (Flow) ON (F, C)

Each flight crewmember shall, during takeoff and landing keep their **shoulder harness** fastened.

Departure Briefing COMPLETE

Normally the majority of this briefing is completed at the gate. The crew should review any subsequent changes to the original briefing, such as runway, SID, or selected automation modes.

Takeoff Announcement..... CABIN READY

The First Officer will use the PRAM if available, or make the takeoff announcement using the following phraseology:

“FLIGHT ATTENDANTS PLEASE BE SEATED FOR DEPARTURE.”

The flight crew will verify the CABIN READY memo message has been received.

Automated TAKEOFF announcement:

From the CABIN INTERPHONE SPEED DIAL page, select LSK 1L, <TAKEOFF FA. This will result in the automated cabin announcement “FLIGHT ATTENDANTS PLEASE BE SEATED FOR DEPARTURE.” This must be verified by observing a **PA IN USE** message in the center CDU scratch pad, or by listening to the PA audio to insure the announcement was made.

Flaps

Note: If the FMC flap selection and the actual flap position are not in agreement, the Electronic Checklist will not reflect a green checkmark.
Never override the Flaps item on the checklist.

Takeoff Check (If Installed)..... CHECKED

The “CHECKED” response refers to the successful completion of the Takeoff Configuration Test. The First Officer will depress the **TAKEOFF CHECK** switch prior to entering the runway and verify that no configuration warnings annunciate.

Transponder.....TA/RA

The Transponder and TCAS are activated by strut sensing on lift off. The predictive windshear function of the radar requires the Transponder / TCAS selector switch to be in the TA/RA position. The TCAS display on the ND (in the MAP, MAP CTR, APP and VOR modes) requires the selection of the TFC switch on the EFIS control panel.

Radar / Terrain (Flow).....AS REQUIRED

The EFIS control panel weather (WXR) map switch control power to the transmitter/receiver and controls the weather radar display on the NDs. The terrain (TERR) switch displays computer generated terrain data on the NDs. WXR and TERR functions should be displayed as desired depending upon weather and surrounding terrain. The terrain function cannot be displayed on an ND with weather radar. If both displays are desired one pilot must display terrain and the other pilot display weather radar.

TAKEOFF NOTES**Takeoff Configuration Warning**

The Takeoff Configuration Warning system is armed when the aircraft is on the ground and the thrust is in the takeoff range on either engine. If a takeoff configuration warning occurs when the throttles are advanced for takeoff prior to reaching 100 knots the takeoff will be rejected, unless the Captain determines that continuing the takeoff is a safer course of action under the conditions.

If a takeoff is rejected, the cause of the warning activation must be corrected prior to attempting another takeoff. If the takeoff is continued, the cause must be determined and corrected or the flight should return to the airport of departure, unless the Captain determines a safer course of action is required.

Reduced Thrust Takeoff

Reduced thrust takeoff using the Assumed Temperature method is the normal procedure whenever performance limits and noise abatement procedures permit. Reduced thrust takeoffs lower EGT, which will extend engine life.

If conditions are encountered during the takeoff where additional thrust is desired, such as a temperature inversion, windshear, or engine failure, the crew should not hesitate to advance thrust.

Load planning will relay the assumed temperature to the flight deck. This temperature will be the most restrictive of the runway limit or climb limit weight (line 7 of Accuload), with 4000 pounds added to allow for last minute passengers and bags. The flight deck crew will enter the assumed temperature into the Takeoff page of the FMC if necessary.

Reduced takeoff thrust is to be used by Continental Airlines on all takeoffs as standard operating procedure.

Reduced thrust takeoff is not authorized under the following conditions:

- Any wheel brake inoperative.
- Thrust Management Computer and both Flight Management Computers inoperative.
- Either engine in ALTN EEC mode.
- Intersection takeoffs or using the shortened runway charts. (Reduced thrust takeoffs are authorized for intersection and shortened runways if the appropriate data is published by CAL Operations Engineering.)
- With improved climb data.
- When V_1 has been increased to equal $V_{1(MCG)}$.
- Reported or suspected windshear.
- Snow, slush, standing water penalty applied, or ice on the runway.
- After application of de-ice/anti-ice fluids.

Note: Reduced thrust takeoff with a tailwind is authorized.

Improved Climb Performance Takeoff

When not field length limited, an increased climb limit weight is achieved by using the excess field length to accelerate to higher takeoff and climb speeds. This improves the climb gradient, thereby raising the second segment weight limit. V1, VR, and V2 are increased to maintain consistent performance relationships.

Improved climb performance data takes into consideration tire and brake energy limits.

Improved climb takeoff is not authorized under the following conditions:

- Any wheel brake inoperative.
- Intersection takeoff.
- With reduced thrust.
- Snow, slush, standing water penalty applied, or ice on the runway.
- With a tailwind.

Note: Improved climb takeoff on a wet runway is authorized.

Intersection Takeoff

The Runway Analysis Data section of the departure paperwork now routinely includes intersection departure data. The intersections are denoted by the runway and intersection identifier in the Takeoff Gross Weights (TGW) section of your paperwork, i.e., 05 H* (Runway 5 at Intersection Hotel). The “*” in the TGW section means there is a remark at the end of the Gross Weights section. For an intersection takeoff the remark provides you with the Runway Remaining Distance from that intersection. Runway Slope has been recalculated for each runway/intersection combination.

Packs OFF Takeoff

If performance mandates a Packs OFF Takeoff be conducted on the B777, refer to the ECL unannounced checklist PACKS OFF TAKEOFF. If the ECL is not available then refer to the Packs OFF Takeoff procedures in Section 2.0, Unannounced, Non-Normal procedures.

To facilitate the use of the ECL procedure, it is recommended that the non-normal checklist be opened as soon as the crew receives ACCULOAD notification that a Packs OFF Takeoff is required. This places the checklist in the non-normal checklist queue and will allow the crew rapid access to the checklist prior to initiation of the BEFORE TAKEOFF checklist.

TAKEOFF PROCEDURE

The Pilot Flying will have the TAKEOFF REF displayed on his/her CDU. The PM will have the LEGS page displayed on his/her CDU. This allows for quick access to data normally required during takeoff and departure. After takeoff, the VNAV CLB page may be displayed to facilitate climb constraint modification. However, climb constraint modification immediately after takeoff is normally accomplished on the mode control panel, using Speed or Altitude intervention.

Thrust Management

Electronic Engine Controls (EEC) simplify thrust management procedures. Having the EEC functioning does not relieve the pilots from monitoring the engine parameters and verifying proper thrust is obtained.

Setting Takeoff Thrust

Flight director and autothrottle use are recommended for all takeoffs. A rolling takeoff is recommended. It expedites takeoff and reduces risk of foreign object damage. As the aircraft is aligned with the runway, the PF will smoothly advance both throttles ensuring symmetrical engine acceleration. When the PF is satisfied that engine acceleration is normal, he/she will engage autothrottles by selecting TO/GA, at approximately 55% N_1 . Unrestricted advancement of the throttles can cause asymmetric thrust with directional control problems, especially on slippery runways. As the throttles reach the end of their forward movement, the PF calls "CHECK POWER", and the PM ensures that the throttles stabilize at takeoff N_1 (referencing the N_1 EICAS indication) and replies "POWER SET ____% (referring to % N_1).". At this point, if the F/O is the PF, the Captain will assume control of the throttles and retain control of the throttles until V_1 .

Check that THR REF appears on both FMA's, and throttles advance to take-off N_1 . Make any final adjustments to takeoff N_1 by 80 knots. Do not readjust thrust settings after 80 knots except to prevent exceeding engine limits.

Takeoff Roll

Keep the aircraft on the centerline with rudder pedal steering and rudder. The rudder becomes effective between 40 and 60 knots. Use of the nose wheel steering tiller during takeoff is not recommended.

Should an EEC fail or malfunction during takeoff, simply reduce power to maintain engine limits. Do not turn off EEC during take-off.

The Captain will guard and retain exclusive control of the throttles from the time initial takeoff power is set until V_1 , and will be prepared to perform the rejected takeoff maneuver if required. When the First Officer is making the takeoff, he/she will place both hands on the yoke after initially setting takeoff power and the Captain has assumed control of the throttles.

Note: Any takeoff requiring a penalty for runway clutter will be executed by the Captain.

The PM monitors EICAS for possible engine exceedance messages and verifies A/T **THR REF** indication changes to **HOLD**. If the **HOLD** mode annunciation does not appear, no crew action is required unless a subsequent system fault caused unwanted thrust lever movement. Lack of the **HOLD** annunciation means the protective feature may not be active, and autothrottle may be unexpectedly engaged during a rejected takeoff. (Normal RTO procedures include disengaging the A/T regardless of speed).

The **HOLD** mode remains engaged until the **PITCH** mode transitions out of **TO/GA** or climb thrust (or maximum continuous, if applicable) is requested through the **CLB/CON** switch on the Mode Control Panel (MCP).

If full thrust is desired while on the runway and **HOLD** mode is displayed, the thrust levers must be manually advanced. After the aircraft is in the air, pushing a **TO/GA** switch advances the thrust to rated takeoff thrust and **THR REF** is annunciated.

At 100 knots, the PM calls out “100 KNOTS.”

The PM will call “ V_1 ” at approximately 5 knots prior to the actual V_1 speed (depending upon acceleration rate) so as to complete the call by the time the airspeed has reached the bug/tape indicator set on the actual V_1 .

The PM will call “**ROTATE**” at V_R , and will then monitor the flight instruments throughout the remainder of the takeoff procedure.

Takeoff with Aft Center-Of-Gravity (C.G.)

When taking off at lightweight and with an aft C.G., the combination of full thrust, rapid thrust application, and sudden brake release may tend to pitch the nose up, reducing nosewheel steering effectiveness. At lightweight and aft C.G., use of reduced thrust and rolling takeoff technique is recommended whenever possible.

Crosswind Takeoff

The crosswind takeoff characteristics are typical of most swept-wing transports.

The upwind wing will tend to rise as the takeoff roll begins. This may be corrected by using aileron as required or by pre-setting a fixed amount of aileron into the wind prior to takeoff roll. Maintain a slight forward pressure on the control yoke until approaching rotation speed. In either case, large control wheel oscillations and inputs should be avoided.

Another indication of a crosswind condition is the tendency of the aircraft to weather vane into the wind, requiring rudder application for directional control.

As speed increases, the aileron deflection requirement will decrease. Continue to maintain directional control with smooth rudder application. This will result in a cross control condition that must be maintained through liftoff. During rotation, hold the control wheel in a displaced position as required to keep the wings level. When airborne, aileron and rudder cross control should be slowly and smoothly relaxed.

Rotation and Liftoff

As the airspeed approaches V_1 , the slight forward control column pressure is relaxed to neutral, allowing for a smooth rotation to begin at V_R . Takeoff and initial climb performance depend on rotating at the correct airspeed and proper rate, to the rotation target attitude. Early, rapid, or over-rotation may cause aft fuselage contact with the runway. Late, slow, or under-rotation increases takeoff ground roll. Any improper rotation decreases initial climb performance.

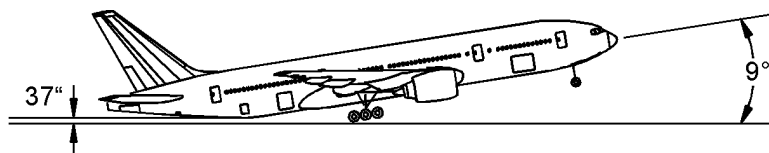
Aft fuselage contact occurs at a pitch attitude of 12 degrees with wheels on the runway and landing gear struts extended.

For optimum takeoff and initial climb performance, initiate a smooth continuous rotation at V_R toward 15 degrees of pitch attitude. Rotate smoothly at an average pitch rate of 2 degrees / second. A 10 degree body attitude will be achieved in approximately 5 seconds.

Note: The flight director pitch command is not used for rotation.

An improper rotation can have an effect on the commanded speed after liftoff. If the rotation is delayed, the speed commanded by the flight director will be liftoff speed plus 15 knots limited to a maximum of $V_2 + 25$. An early liftoff does not affect the commanded initial climb speed; however, either case will degrade overall takeoff performance.

When a positive rate of climb has been verified on the IVSI and altimeter, either pilot will call, "POSITIVE RATE." When a positive rate of climb is confirmed, the PF will call "GEAR UP," stabilize airspeed at $V_2 + 15$ to 25 knots, and transition to the F/D pitch command. Cross check indicated airspeed and other flight instruments. If the flight director is not used indicated airspeed and attitude become the primary pitch references.



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777 TYPICAL TAKEOFF TAIL CLEARANCE

Aft Fuselage Contact During Takeoff (Tail Strike)

Tail strikes have resulted in major aircraft damage or unnecessary down time. Airplanes at light takeoff gross weights are most vulnerable to tail strike incidents. The rapid acceleration may catch pilots by surprise and unprepared to perform a smooth, steady rotation. Rapid rotation to an initial target climb speed will almost certainly result in a tail strike.

Avoid any tendency to rapidly rotate to a 10 degree pitch attitude and hold it until lift-off. This technique invites a tail strike.

Aft fuselage contact will occur at a pitch attitude of 12 degrees on the B777.

Caution: Do not pressurize an aircraft that has not been inspected for structural damage after fuselage runway contact. Refer to the TAIL STRIKE ON TAKEOFF Checklist in Non-Normal section. A landing at the nearest suitable airport is recommended.

Noise Abatement

All Continental aircraft are expected to comply with FAR 36 Noise Abatement Requirements. Every takeoff should adhere to the standard noise abatement profile (ICAO A). A few airports will have procedures that allow the alternate profile (ICAO B). Safety is of primary concern when following the noise abatement profile. Pilot judgment may require adjustments due to adverse winds, weather, or other flight conditions.

Obviously, engine failures or other mechanical problems may require abandonment of noise abatement procedures.

Close In Turn After Takeoff

Normally, a turn after takeoff should not be started until reaching 400 feet AGL, even if ATC requests a turn as soon as practical. However, a turn required for obstructions, noise abatement, or adverse conditions may be started before reaching 400 feet AFE but, no lower than 50 feet AFE. The maximum bank angle after takeoff will be 15 degrees until reaching $V_2 + 15$. At an airspeed of $V_2 + 15$ and above, bank angles of 25 degrees are allowable.

For a minimum radius turn, maintain $V_2 + 15$ to 25 knots with takeoff flaps. After completion of the turn, and at or above flap retraction altitude, reduce climb rate and retract flaps on the flap speed schedule.

Autopilot Engagement

The autopilot may be engaged any time above 1,000-ft. AGL. When the initial climb is established, ensure the aircraft is trimmed to meet the F/D roll and pitch commands; then select either the Captain or First Officer A/P switch. The Pilot Flying normally engages the autopilot and announces the action.

Takeoff Pitch Modes

Normally, TO/GA is engaged and VNAV is armed for takeoff and engages at 400' AFE. The use of VNAV for takeoff, flap retraction and climb out is the preferred method of managing the AFDS for takeoff. This provides the VNAV profile and acceleration schedule compatible with the planned departure and overspeed protection for flaps.

FLCH is used if VNAV is not available or not desired. Selection of FLCH will automatically select Climb Thrust. If thrust reduction and flap retraction altitude are the same (i.e., ICAO B), the PF calls "FLIGHT LEVEL CHANGE - CHECK TOP BUG." The PM/PF verifies climb thrust, and adjusts the command airspeed cursor to flaps up maneuvering speed. Flaps are retracted on schedule.

If the thrust reduction altitude and flap retraction altitude are not the same (i.e., ICAO A), the PF calls "CLIMB POWER" at the thrust reduction altitude. The PM/PF selects **CLB/CON** on the MCP and verifies climb thrust. At the flap retraction altitude the PF calls "FLIGHT LEVEL CHANGE - CHECK TOP BUG." The PM/PF adjusts the command airspeed cursor to flaps up maneuvering speed and the flaps are retracted on schedule.

VNAV Engagement

With VNAV engaged, the FMC commands AFDS pitch and A/T modes to fly the vertical profile selected on the FMC. Therefore, the mode control panel IAS display becomes blank, and the command airspeed bugs (cursors) are positioned at the FMC commanded airspeed on the airspeed indicator tape. The AFDS controls pitch to maintain FMC speed. With VNAV engaged, pushing the IAS/MACH selector enables speed intervention. Speed intervention allows the flight crew to change aircraft speed with the IAS/MACH selector.

The FMC will command a 250 knot climb speed once the flaps have been retracted. Placing a speed restriction (with or without a corresponding altitude restriction) into the FMS on the CLMB page can alter FMC initial climb speed.

This may be desirable when specific clearance, SID compliance, or special noise abatement procedures are required. On some international flights, speeds above 250 knots below 10,000' MSL are authorized. The FMC CLB page can be edited to delete the 250 knot restriction.

To reinstate speed control through the MCP, select FLCH or use speed intervention.

MANEUVERING

Flap Retraction Schedule

Maintain flaps up maneuvering speed until the noise abatement profile is satisfied, until clear of obstacles or above any minimum crossing altitude. This is normally achieved through the FMC speed altitude restriction entered on the CLB page. It may also be accomplished using speed intervention or FLCH.

At flap retraction altitude, normally 3,000' above field elevation, adjust the pitch attitude to maintain a slight climb. Accelerate and retract the flaps on schedule.

With VNAV engaged, acceleration is automatically commanded. Retract flaps on schedule. Check that the thrust reference changes from **TO** to **CLB** on the EICAS at the point selected on the TAKEOFF REF page.

If VNAV is not used, select FLCH and set the selected speed bug to flaps up maneuvering speed. Check that the thrust reference changes from **TO** to **CLB** on the EICAS. If the thrust reference does not change automatically, set climb thrust using the CLB/CON switch on the MCP.

Flap movement to the next position should be initiated when within 20 knots of the maneuver speed for the next flap position. Accelerate to the next maneuver speed while the flaps are retracting. Acceptable maneuver margin exists at speeds 20 knots below the recommended maneuver speed for each flap position.

Flap retraction should be initiated at the maneuver speed on the speed tape. The maneuver speed will provide adequate buffet margin for bank angles up to 40 degrees.

Takeoff Flap Setting	Select Flaps	At V_{ref} Plus
20/15	5	20
	1	40
	Up	60
5	1	40
	Up	60
Final Climb	V _{ref} + 80	

VNAV OPERATION - TAKEOFF

The VNAV takeoff phase is initiated at the completion of the preflight phase (all boxed prompts loaded on the PERF INIT page), and is active until the FMC commands climb thrust as defined on TAKEOFF page 2/2.

During takeoff, the FMC records the barometric altitude on the runway as the aircraft accelerates through 100 Kts. This altitude is used to:

- engage VNAV (400 ft),
- enable autothrottle activation (400 ft),
- command acceleration for engine out flap retraction (TAKEOFF page 2/2),
- command acceleration for normal flap retraction (TAKEOFF page 2/2), and
- set climb thrust (TAKEOFF page 2/2).

FMA ANNUNCIATIONS

Verify VNAV engages at 400 ft above runway elevation (ARE) by observing one of the following FMA AUTOTHROTTLE and PITCH mode annunciations (3000 ft acceleration altitude):

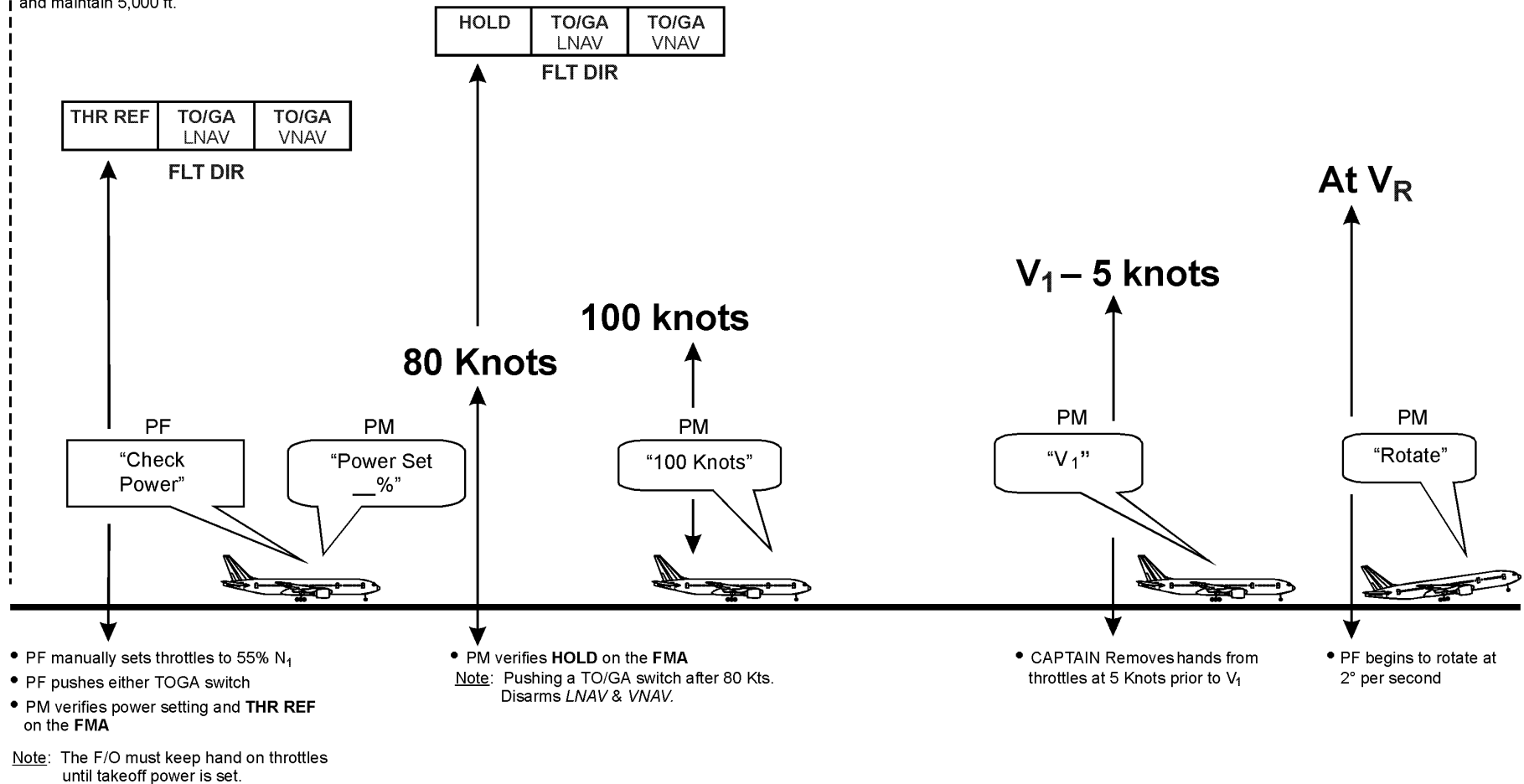
THR REF	and	VNAV SPD	-	Normal when climbing to an altitude above 3000 ft ARE during takeoff.
SPD	and	VNAV ALT	-	The MCP altitude has been captured prior to the TAKEOFF page 2/2 altitude and VNAV has commanded an acceleration.
SPD	and	VNAV PTH	-	A CDU altitude has been captured prior to the TAKEOFF page 2/2 altitude and VNAV has commanded an acceleration.

Note: The vertical climb rate during takeoff and the altitude in the MCP altitude window or the CDU altitude constraints determine when the FMA Pitch mode of **VNAV ALT** or **VNAV PTH** annunciates. (i.e., Climbing to an altitude at or below 3000 ft ARE at light weight and cool temperature.)

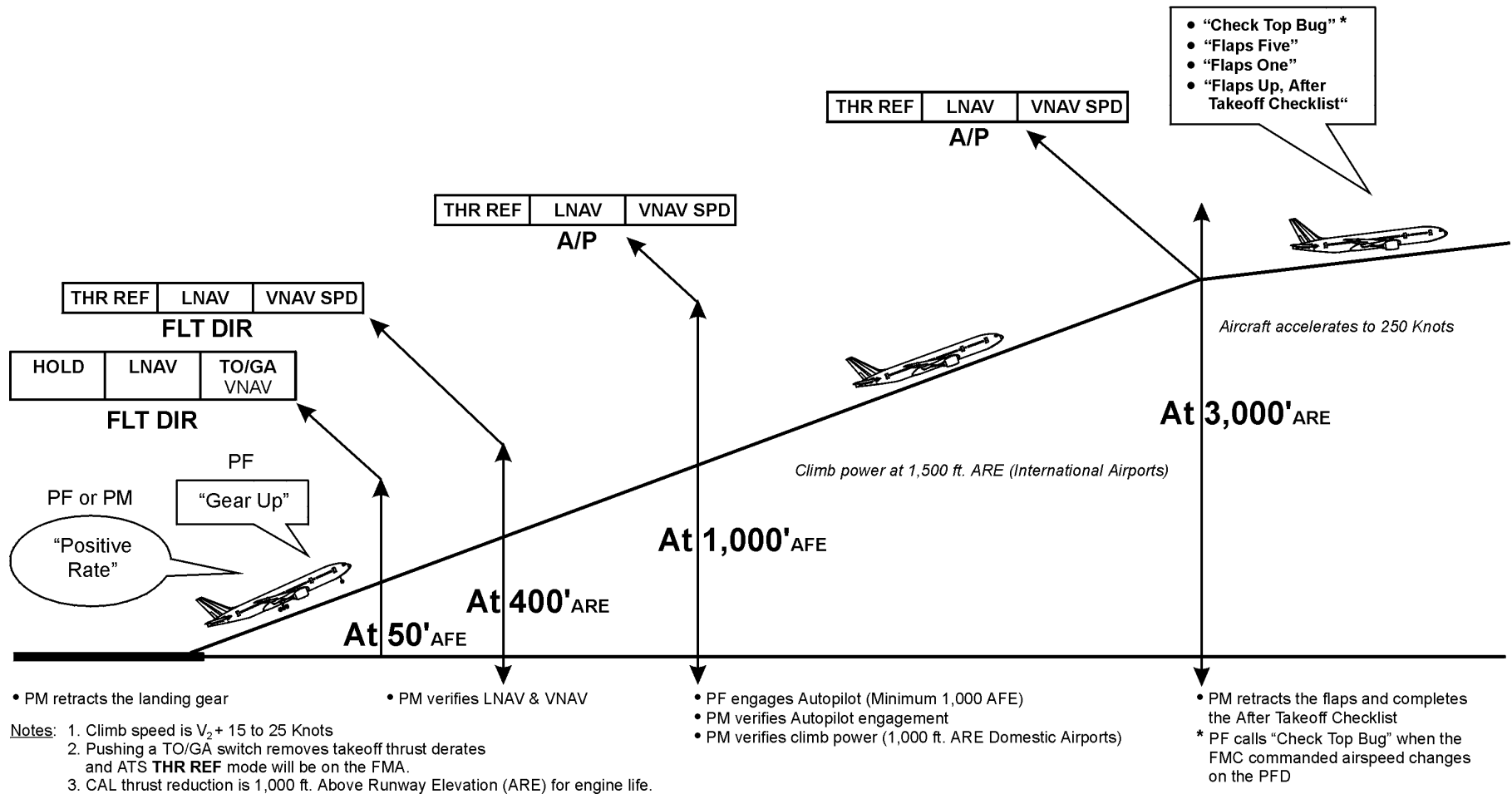
TAKEOFF PROCEDURE CHART
STANDARD NOISE ABATEMENT PROFILE (ICAO A)

PHASE OF FLIGHT	PILOT FLYING: DUTIES/CALLOUTS	PILOT MONITORING: DUTIES/CALLOUTS	FMA DISPLAY				NOTES
			A/T	ROLL	PITCH	AFDS	
Cleared onto active runway	(Captain) • Call for "BEFORE TAKEOFF CHECKLIST."	(First Officer) • Complete Before Takeoff Flow and Checklist.		TO/GA LNAV	TO/GA VNAV	FLT DIR	Autoflight mode displays are based on normal procedures. Other displays are possible if all autoflight features are not used.
Cleared for takeoff	• Advance throttles toward 55 % N ₁ allow to stabilize. • Engage TO/GA switch. • Call "CHECK POWER."	• Observe THR REF annunciation. • Crosscheck power setting and adjust to desired T/O setting prior to 80 knots. • Call "POWER SET _____ %N ₁ ."	THR REF	TO/GA LNAV	TO/GA VNAV	FLT DIR	If in HOLD, set power manually. Engage TO/GA by 50 knots or ATS cannot be engaged until above 400'.
80 knots to V ₁	Captain Takeoff: • Verify airspeed at 100 knots call. First Officer Takeoff: • Place both hands on control yoke after initial power set. • Verify airspeed at 100 knots call.	• Observe HOLD at 80 knots. • Monitor Instruments and Warning Lights. • At 100 KIAS call "100 KNOTS." First Officer Takeoff: • Captain guards and retains exclusive control of throttles after initial power set.	HOLD	TO/GA LNAV	TO/GA VNAV	FLT DIR	
V ₁ , V _R , Rotation and Liftoff	• Captain removes hand from throttles at V ₁ . • Rotate at V _R (2°/Sec.) to target pitch for V ₂ + 15 • Call "POSITIVE RATE, GEAR UP."	• Call "V ₁ ." • Call "ROTATE." • Call "POSITIVE RATE." • Retract Gear on Command.	HOLD	TO/GA LNAV	TO/GA VNAV	FLT DIR	Do not exceed normal rotation rate (2° / Sec.) as tail contact with the runway is possible. Verify positive rate on both VSI & Altimeter.
50' AGL	• LNAV engages.	• Verify FMA annunciation.	HOLD	LNAV	TO/GA VNAV	FLT DIR	Turns are not normally initiated before 400' AGL. HDG SEL preferred if being vectored.
400' AGL	• VNAV engages.	• Verify VNAV engages.	THR REF	LNAV	VNAV SPD	FLT DIR	
1,000' AGL	• Engage autopilot and announce	• Verify autopilot engagement.	THR REF	LNAV	VNAV SPD	A/P	
(1,000' AGL) 1,500' AGL	• Monitor thrust change	• Verify thrust change to CLB.	THR REF	LNAV	VNAV SPD	A/P	T/O changes to selected CLB mode, on EICAS when altitude or flap setting are reached as selected on T/O REF page 2/2.
3,000' AGL	• "Check Top Bug" • Monitor acceleration and retract flaps on schedule. • Call for After Takeoff Checklist.	• Verify Top Bug • Retract flaps as directed. • Conduct After Takeoff flow and Checklist.	THR REF	LNAV	VNAV SPD	A/P	Acceleration will occur at altitude selected on T/O REF page 2/2. Retraction to the next flap setting should be initiated at 20 knots below the maneuvering speed for the lower flap setting. CDU updates below 10,000' should be avoided if they decrease vigilance outside for collision avoidance.

Normal Takeoff Profile (Modified ICAO A) (LNAV & VNAV) Takeoff Thrust Thru Rotation

CLEARANCECleared for takeoff, climb
and maintain 5,000 ft.

Normal Takeoff Profile (Modified ICAO A) (LNAV & VNAV) Initial Climb ($V_2 + 15$ Knots) And Acceleration



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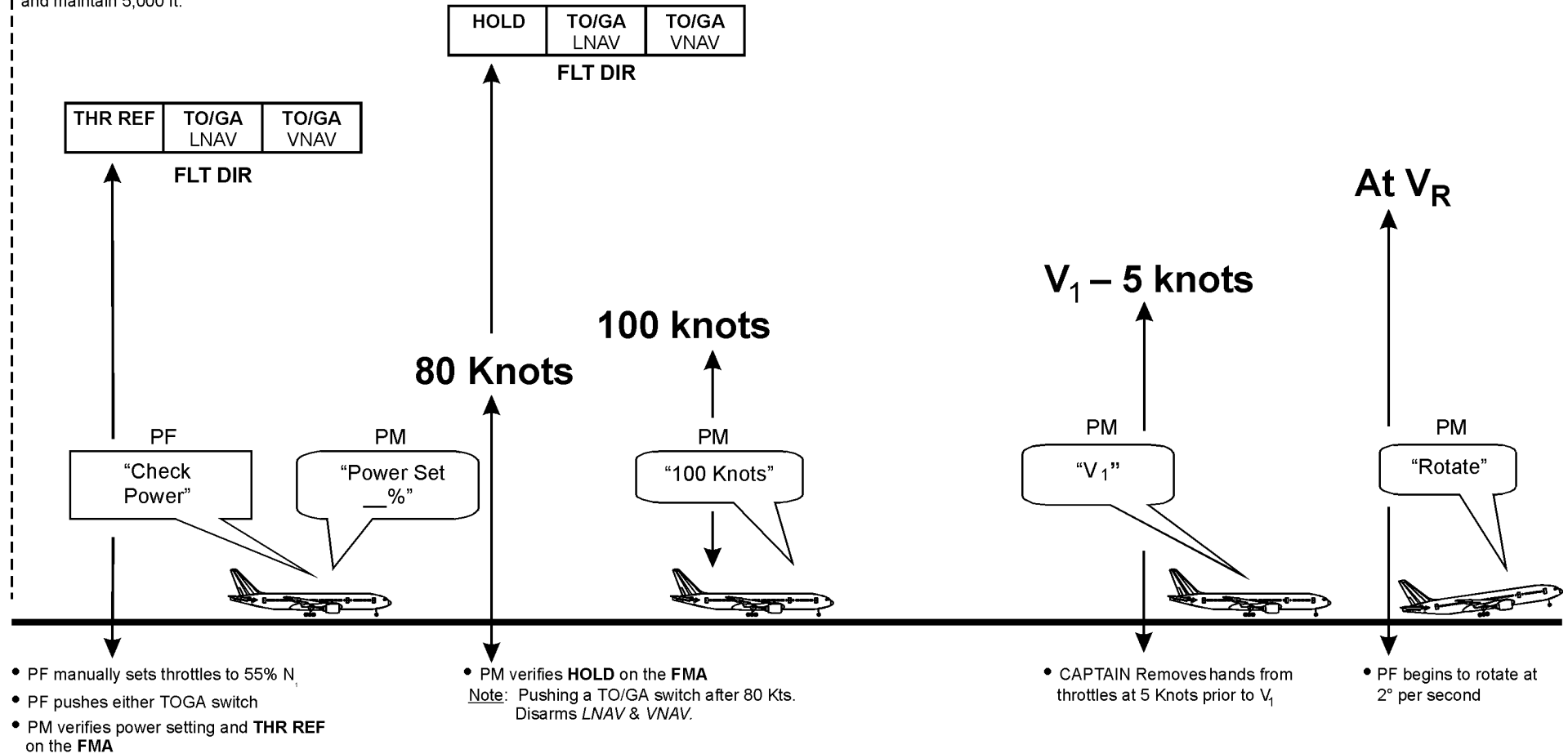
TAKEOFF PROCEDURE CHART
ALTERNATE NOISE ABATEMENT PROFILE (ICAO B)

PHASE OF FLIGHT	PILOT FLYING: DUTIES/CALLOUTS	PILOT MONITORING: DUTIES/CALLOUTS	FMA DISPLAY				NOTES
			A/T	ROLL	PITCH	AFDS	
Cleared onto active runway	(Captain) • Call for "BEFORE TAKEOFF CHECKLIST."	(First Officer) • Complete Before Takeoff flow and Checklist.		TO/GA LNAV	TO/GA VNAV	FLT DIR	Autoflight mode displays are based on normal procedures. If LNAV is not used call for appropriate mode at 400'.
Cleared for takeoff	• Advance throttles toward 55% N ₁ and allow to stabilize. • Engage TO/GA and verify thrust advances to reference. • Call "CHECK POWER."	• Observe THR REF annunciation • Crosscheck power setting and adjust to desired T/O setting prior to 80 knots. • Call "POWER SET ____%"	THR REF	TO/GA LNAV	TO/GA VNAV	FLT DIR	If in HOLD, set power manually. Engage TO/GA by 50 knots or ATS cannot be engaged until above 400'.
80 knots to V ₁	Captain Takeoff: • Verify airspeed at 100 knots call. First Officer Takeoff: • Place both hands on control yoke after initial power set. • Verify airspeed at 100 knots call.	• Observe HOLD at 80 knots. • Monitor Instruments and Warning Lights. • At 100 KIAS call "100 KNOTS." First Officer Takeoff: • Captain guards and retains exclusive control of throttles after initial power set.	HOLD	TO/GA LNAV	TO/GA VNAV	FLTDIR	
V ₁ , V _R , Rotation and Liftoff	• Captain removes hand from throttles at V ₁ . • Rotate at V _R (2° / Sec.) to target pitch for V ₂ +15. • Call "POSITIVE RATE "GEAR UP.""	• Call "V ₁ ." • Call "ROTATE." • Call "POSITIVE RATE." • Retract Gear on Command.	HOLD	TO/GA LNAV	TO/GA VNAV	FLT DIR	Do not exceed normal rotation rate (2° / Sec.) as tail contact with the runway is possible. Verify positive rate on both Vsi & Altimeter.
50' AGL	• LNAV engages.	• Verify FMA annunciation.	HOLD	LNAV	TO/GA VNAV	FLT DIR	Turns are not normally initiated before 400' AGL. HDG SEL preferred if being vectored.
400' AGL	• VNAV engages.	• Verify VNAV annunciation.	THR REF	LNAV	VNAV SPD	FLT DIR	
1,000' AGL	• "Check Top Bug" • Engage autopilot and announce • Retract flaps on schedule. • Call for After Takeoff Checklist	• Verify Top Bug • Verify autopilot engagement. • Retract flaps as directed. • Complete After Takeoff flow and Checklist.	THR REF	LNAV	VNAV SPD	A/P	T/O changes to selected CLB mode, on EICAS when altitude or flap setting are reached as selected on T/O REF page 2/2. Retraction to the next flap setting should be initiated at 20 knots below the maneuvering speed for the lower flap setting.
3,000' AGL	• Monitor acceleration profile	• Update LNAV waypoints as required.	THR REF	LNAV	VNAV SPD	A/P	CDU updates below 10,000' should be avoided if they decrease vigilance outside for collision avoidance. Ensure PF awareness of any FMC changes.

Alternate Takeoff Profile (Modified ICAO B) (LNAV & VNAV) Takeoff Thrust Thru Rotation

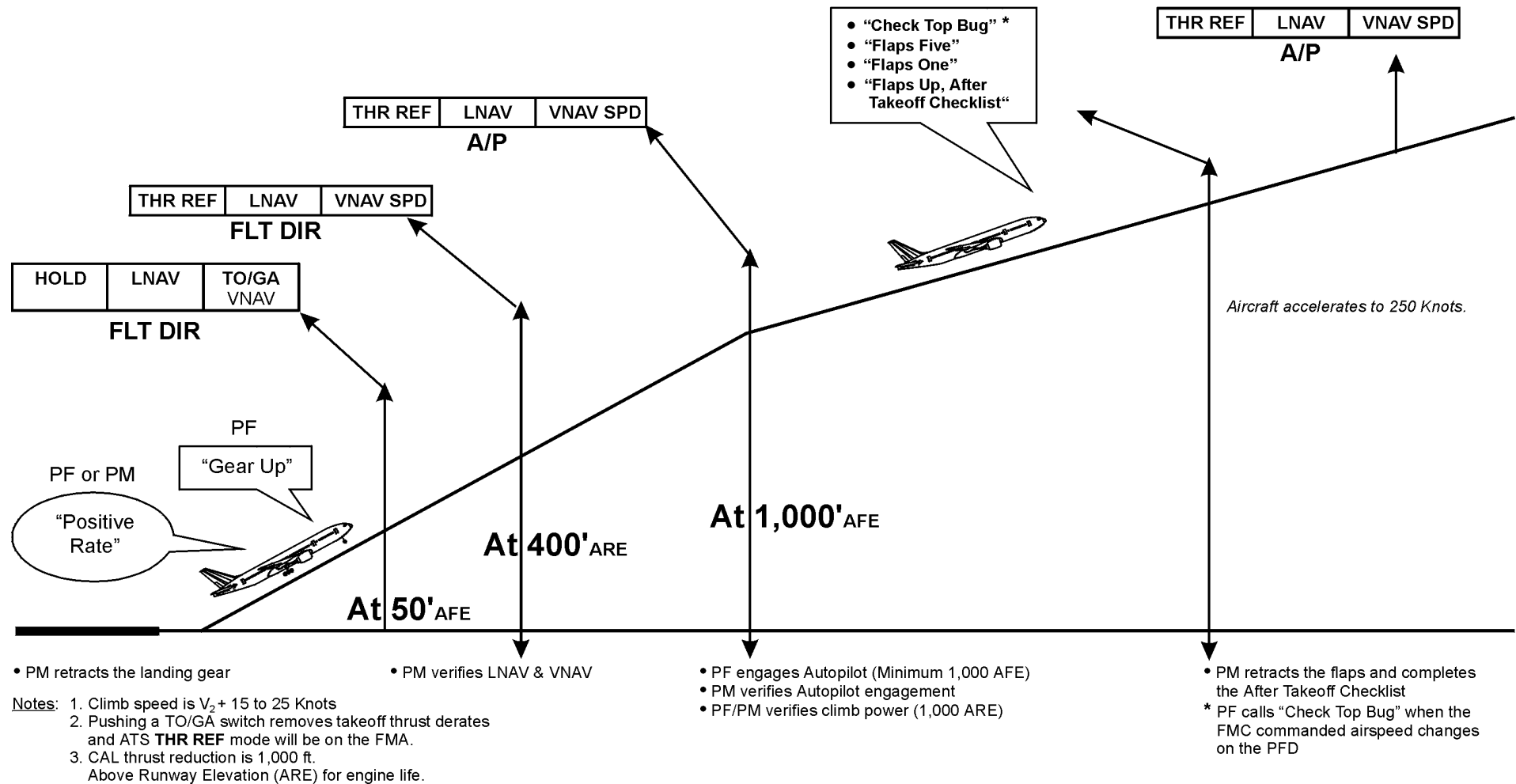
CLEARANCE

Cleared for takeoff, climb
and maintain 5,000 ft.



Note: The F/O must keep hand on throttles until takeoff power is set.

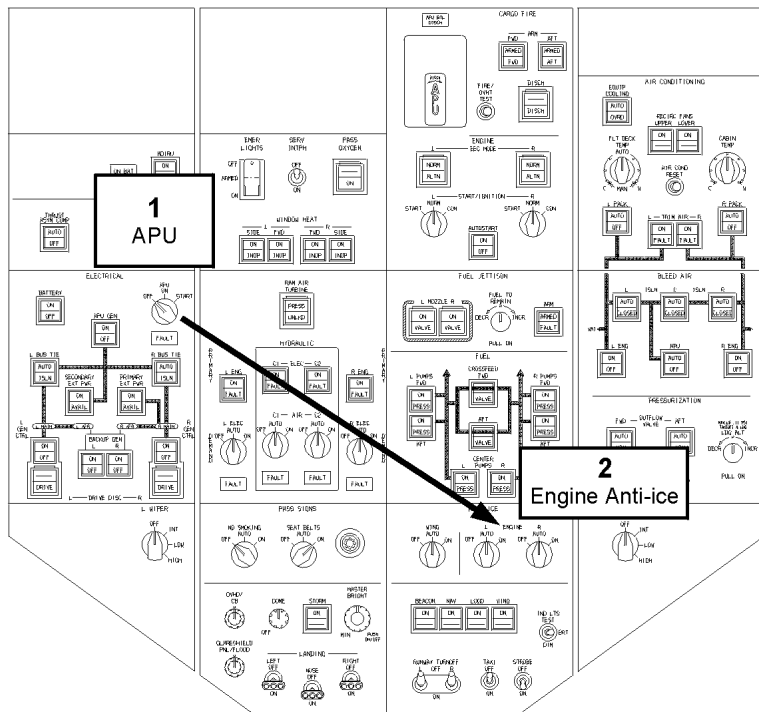
Alternate Takeoff Profile (Modified ICAO B) (LNAV & VNAV) Initial Climb ($V_2 + 15$ Knots) And Acceleration



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AFTER TAKEOFF FLOW



PM

1. APU OFF
2. Engine Anti-ice AUTO

AFTER TAKEOFF

The Pilot Flying should call for the AFTER TAKEOFF Checklist in conjunction with the flaps up call. The Pilot Monitoring will ensure the procedures have been accomplished then complete the checklist. Do not allow the reading of the checklist to interfere with outside vigilance while departing the terminal area.

PM Challenge	AFTER TAKEOFF	PM Respond
Gear		UP
Flaps		UP

PM Challenge**PM Respond**

Gear..... **UP**

UP (white) all landing gear are up and locked (indication blanks after 10 seconds).

Flaps..... **UP**

UP (white) the slats and flaps are retracted (indication blanks after 10 seconds).

APU (Flow) **OFF**

Turn off the APU if it is no longer needed.

Engine Anti-Ice (Flow) **AUTO**

Select EAI switches to AUTO if they were turned to the ON position during taxi and takeoff.

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CLIMB**Thrust Management**

Once climb thrust is set, the EEC automatically compensates for the various changes in environmental conditions during the climb and maintains climb thrust. With the EEC's in the alternate mode, thrust should be manually adjusted, as necessary, to ensure that the selected climb thrust is maintained.

The use of reduced climb thrust will result in an increase in the climb distance. This distance is dependent upon performance variables and the extent to which a thrust reduction is used.

Reduced Thrust for Climb

Engine maintenance benefits may be realized by operating the engines at less than full climb rated thrust.

Two climb derate options are offered in the Flight Management Computer (FMC).

- CLB 1 uses a constant 10% derate of maximum climb thrust to 10,000' then increases thrust linearly to maximum climb thrust at 12,000 feet.
- CLB 2 uses a constant 20% derate of maximum climb thrust to 10,000' then increases thrust linearly to maximum climb thrust at 12,000 feet.

The gradually reduced derate method increases climb thrust to maximum rating as the aircraft climbs.

Use of an assumed temperature reduced thrust takeoff will affect automatic selection of climb derate. For a takeoff thrust reduction or derate of up to 5%, maximum climb thrust is automatically selected by the FMC.

On the ground the pilot may override the automatic derate selection after the takeoff selection has been completed. The automatic selection of CLB1 or CLB2 results in no throttle advance during the transition from takeoff to climb mode, and good rate of climb performance.

Climb Constraints

Climb constraints may be automatically entered in the route when selecting a departure procedure, or manually entered through CDU entry. When the aircraft levels off at a MCP altitude, that altitude is treated as a climb constraint by the FMS.

When initiating a climb with multiple climb altitude constraints the highest cleared altitude will be set in the MCP altitude window.

Each push of the MCP altitude selector knob deletes the next waypoint altitude constraints between the airplane altitude and the altitude window. CLIMB DIR will delete all altitude constraints from the LEGS page up to the altitude set in the MCP altitude window.

When relieved of constraints by ATC, use the CLIMB DIRECT function or the MCP altitude knob to clear constraints from the FMC. Use of MCP altitude intervention is recommended in congested areas, or during times of high workload.

Caution: If a VNAV mode is not engaged during the climb, or disengages, all hard altitude constraints must be set in the MCP altitude window.

Low Altitude Level Off

Occasionally a low altitude climb restriction is required after takeoff. This altitude restriction should be put in the MCP altitude window. When the aircraft approaches this altitude, the mode annunciation changes to **ALT**, **VNAV ALT**, or **VNAV PTH** and the aircraft levels off. The autothrottle **SPD** mode engages and controls to the bug speed.

Normal Climb Speed

Maintain $V_{REF} 30+80$ knots until clear of obstacles or above minimum crossing altitudes. If there are no altitude or airspeed restrictions, accelerate to the desired climb speed schedule. The sooner the aircraft can be accelerated to the climb speed schedule, the better the overall flight efficiency from a fuel conservation and enroute flight time standpoint.

Enroute climb speed is automatically computed by the FMC and displayed on the CLB and PROGRESS 1/2 pages, as well as by the command speed bug on the PFD when VNAV is engaged. Below the speed transition altitude the FMC will target the transition speed limit stored in the Navigation Data Base for the departure airport (250 knots in the USA).

The FMC increases this speed to a minimum of flaps up speed, if necessary, to ensure that full maneuvering capability is available following flap retraction. The FMC will also apply waypoint-related speed restrictions entered on the LEGS pages, and altitude-related speed restrictions entered on the CLMB page.

The FMC provides optimum climb speed modes for economy (ECON) operation and engine-out (ENG OUT) operation. These optimum speeds can be overwritten by IAS, IAS/Mach, or Mach values before or during the climb. Reference speeds are also provided for maximum angle climb (MAX ANGLE) operation.

The ECON climb speed is a constant speed/Mach schedule optimized to obtain the minimum aircraft operating cost per mile, and is based upon the entered cost index. The constant Mach value is set equal to the economy cruise Mach calculated for the cruise altitude entered in the FMC.

For very low cruise altitudes, the economy climb speed is increased above normal values to match the economy cruise speed at the entered cruise altitude. For ECON climb, the speed is a function of gross weight (predicted weight at top of climb), predicted top of climb wind, predicted top of climb temperature deviation from ISA, and cost index.

In the event FMS-computed climb speeds are not available, use the speeds on the flight plan.

Maximum Angle of Climb

Maximum angle climb speed is normally used for obstacle clearance, minimum crossing altitude, or to reach a specified altitude in a minimum distance. It varies with gross weight and is referenced to $V_{REF} 30$. For practical purposes flaps up maneuvering speed ($V_{REF} 30 + 80$) or .80 Mach can be used for all gross weights. Select MAX ANGLE on CLB page.

Maximum Rate of Climb

Maximum rate climb provides both high climb rates and minimum time to cruise altitude. Use 300 knots until reaching .84 Mach. Engine Inoperative Climb can approximate it.

Normal Economy Climb

The normal economy climb speed schedule minimizes trip cost. It varies with gross weight and is influenced by cost index. The FMC generates a variable speed schedule as a function of cost index and weight.

Economy climb speed exceeds 250 knots for all gross weights. FMC climb speed below 10,000' is limited to 250 knots or $V_{REF} 30 + 80$ knots, whichever is greater.

If ATC permits the use of a higher speed below 10,000', the use of ECON speed may provide additional cost savings. The speeds in the following table may be used when performance data is not available from the flight management computer.

Climb Speeds

Altitude	Speed
Sea Level to 10,000'	250 knots / $V_{REF} 30 + 80$
Above 10,000'	310 knots / .84 Mach

VNAV OPERATION - CLIMB

The VNAV climb phase is initiated when reaching the thrust reduction altitude entered on TAKEOFF page 2/2, and continues until reaching the entered cruise altitude at the top of climb (T/C) point.

The VNAV CLB page provides access to the parameters defining the climb phase, and is used to evaluate, monitor and modify the climb path. It also provides engine out performance data. The VNAV CLB page is the default VNAV page displayed when the VNAV function key is selected prior to reaching T/C (VNAV operating in climb phase).

INITIAL CLIMB

Verify that thrust reduction occurs at the FMC generated altitude of 1000 ft ARE (1500 ft for international airports), by observing throttle movement, engine sound, and the proper EICAS indication of **CLB**, **CLB 1**, or **CLB 2**.

Verify VNAV commands an acceleration (limited by flap/slats or gear configuration) at the FMC generated altitude of 3000 ft ARE for a modified ICAO A (1000 ft for modified ICAO B), by observing that FMC airspeed has changed from the speed at VNAV engagement to one of the following:

190 kts for 20° flap takeoff	(flap limit speed is 195 kts)
210 kts for 15° flap takeoff	(flap limit speed is 215 kts)
230 kts for 5° flap takeoff	(flap limit speed is 235 kts)

CAUTION: Never allow the current airspeed pointer to be in the red and black maximum airspeed indications on the PFD airspeed tape.

Note: VNAV also commands an acceleration (limited by flap/slats or gear configuration) when the MCP or CDU altitude is captured prior to the acceleration altitude entered on TAKEOFF page 2/2.

The PF calls for the next flap retraction schedule when the green flap maneuvering speed number on the airspeed tape is at or below the pointer on the current airspeed window. If the flaps are not positioned to the next flap setting the aircraft accelerates to a speed 5 kts below the current flap limit speed until an altitude is captured (autothrottles control speed), or the flap handle is moved to the next lower flap setting.

When the flaps/slats are retracted VNAV commands an acceleration to the VNAV climb speed of:

- 250 kts, or
- the speed transition associated with the origin airport, or
- the speed entered on the VNAV CLB page SPD RESTR line.

After the gear and flaps are retracted and all speed transitions or speed/altitude restrictions are met, the CLB page title becomes ACT 250KT CLB. At the speed transition altitude the CLB page title changes to ACT ECON CLB (or the pilot selected climb mode of ACT XXXKT CLB).

For VNAV to operate successfully, it must be understood that when the ATC departure clearance has a SID with altitude/speed constraints the PF must set the highest altitude for the SID in the MCP altitude window. This allows VNAV to fly the CDU altitude profile that matches the SID climb profile. (The exception being an ATC altitude constraint below the highest altitude.)

FMA ANNUNCIATIONS

The FMA AUTOTHROTTLE and PITCH mode annunciations during the VNAV climb phase are:

THR REF	and	VNAV SPD	-	Normal climb mode until reaching an altitude constraint on the ACT RTE X LEGS page, MCP altitude, or cruise altitude.
SPD	and	VNAV ALT	-	When reaching an MCP altitude that is not the cruise altitude or an altitude constraint on the ACT RTE X LEGS page.
SPD	and	VNAV PTH	-	When reaching the cruise altitude or an altitude constraint on the ACT RTE X LEGS page. (The MCP altitude may or may not be the same altitude.)

SPEED AND ALTITUDE RESTRICTIONS

ATC speed restrictions without an altitude constraint should be made using the MCP speed selector knob (VNAV speed intervention). When the restriction is removed, push the MCP speed selector knob to resume normal FMC speed control.

ATC speed restrictions with an altitude constraint should be accomplished using the VNAV CLB page SPD RESTR line. If the restriction is removed delete the SPD RESTR line and resume normal FMC speed control.

When given approval for a high speed climb below 10,000 ft, delete the SPD TRANS line on the VNAV CLB page.

The FMA annunciation **VNAV ALT** indicates that the altitude set in the MCP window has been captured and is different from the FMC altitude. To resume the climb, set the new altitude in the MCP altitude window and push the MCP altitude knob.

WAYPOINT / FIX ALTITUDE CONSTRAINTS

The VNAV pitch mode annunciated on the FMA during climb is normally **VNAV SPD**; however, when VNAV complies with an FMC waypoint or fix altitude constraint **VNAV PTH** is the pitch mode.

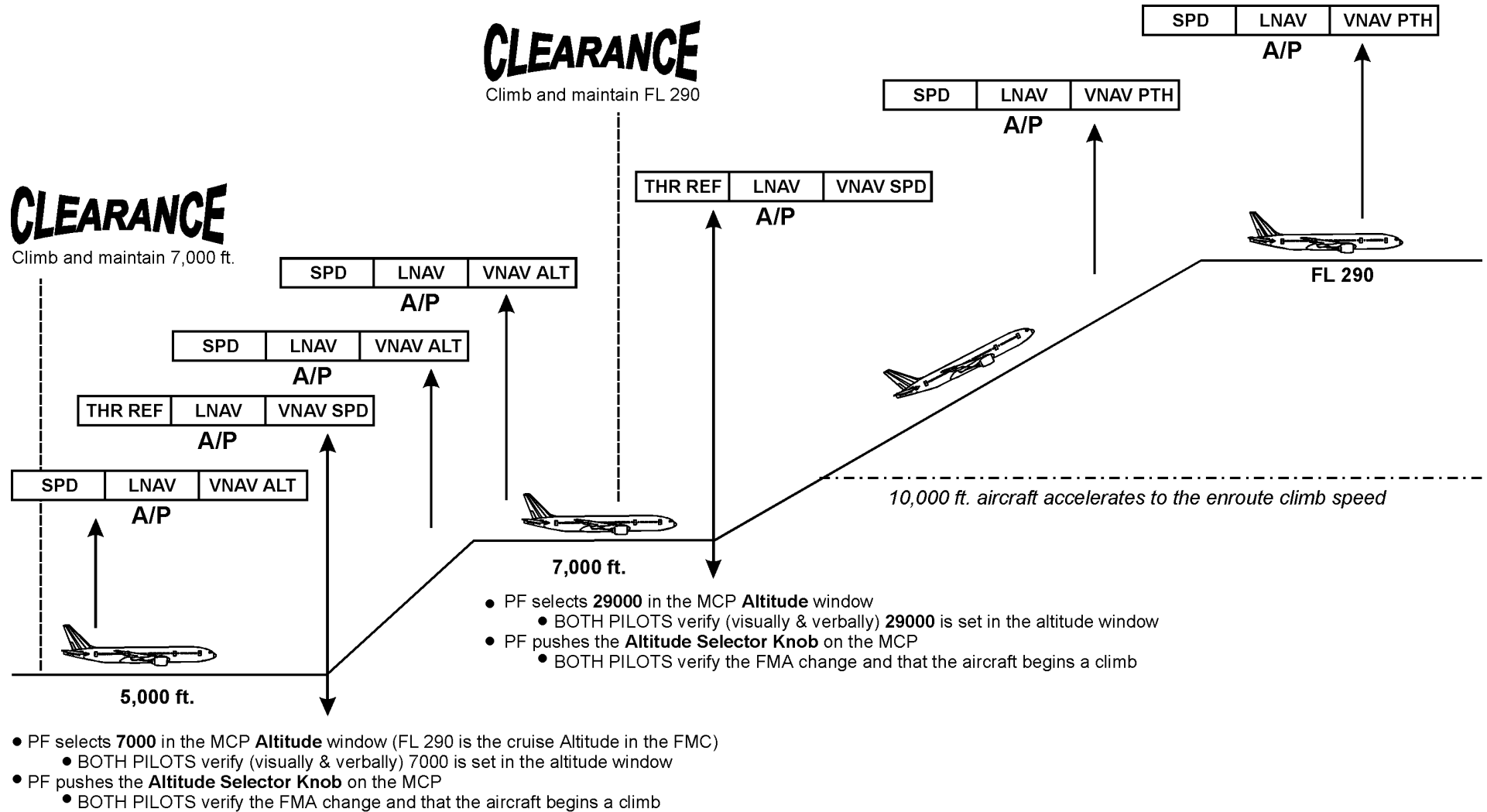
If VNAV is unable to comply with waypoint altitude constraints, the FMC message **UNABLE NEXT ALTITUDE** is displayed in the CDU scratch pad. Changing to a slower speed profile is required to comply with the constraint.

With the MCP altitude set above the altitude constraint, waypoint or fix altitude constraints may be deleted as follows:

- Each push of the MCP altitude knob (altitude intervention) deletes one altitude constraint, up to but not including the MCP altitude, or
- Pushing CLB DIR at 6R on the VNAV CLB page deletes all altitude constraints up to but not including the MCP altitude.

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Climbs with Vertical Navigation (VNAV SPD)



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CRUISE**Altitude Selection**

The altitude selection for cruise should normally be as close to optimum as possible. Optimum altitude is the altitude that gives the best fuel mileage for a given trip length, cost index, and gross weight. It provides at least 1.25g or better buffet margin. As deviation from optimum cruise altitude increases, computed best economy speeds for the existing conditions are slower. For LRC and selected speed modes, fuel mileage is optimized. For short range flights, the optimum altitude accounts for optimum cruise time requirements.

If altitude changes enroute are difficult to obtain, some thought should be given to selecting an initial cruise altitude based on maximum thrust limits. Selecting a cruise thrust limited altitude is dependent upon the cruise level temperature. Some loss of buffet margin can be expected above optimum altitude; however, 2,000' above optimum altitude will normally allow approximately 45° bank prior to buffet onset. The higher the aircraft flies above optimum altitude, the more buffet margin is reduced. Before accepting an altitude above optimum, determine that it is, and will continue to be, acceptable as the flight progresses under projected conditions of temperature and turbulence. Do not operate at buffet margins less than 1.25g or 3,000 to 4,000' above optimum altitude for normal flight.

Step Climb

Step altitudes can be planned as step ups or step downs at waypoints or they can be optimum step points calculated by the FMC. Optimum step points are a function of the route, flight conditions, speed mode, present aircraft altitude, STEP TO altitude (or adjacent STEP TO altitudes) and the gross weight. However, the step climb point does not consider wind at the STEP TO altitude in the calculation.

The FMC computed step point provides for minimum trip cost for the flight, including allowances for the climb fuel. As close as practicable to the step climb point, initiate a cruise climb to the new altitude. If no step climbs are made, it is important to enter zero for the step size so that the performance calculations computes the most fuel efficient solution and makes accurate fuel predictions. Otherwise, the performance calculation assumes the computed optimum steps are made, possibly resulting in non-conservative predictions of fuel at destination.

Note: CAL flight plans use a maximum altitude based on the lessor of:

1. 1.3g buffet protection 25° bank angle with a 15° overshoot.

2. 300 FPM climb at maximum cruise thrust, which equates to a sustained 21° bank angle turn.

Maximum Altitude

Maximum altitude is the highest altitude to which the aircraft will be flown. The FMC planned climb speed and selected cruise speed will not be affected by the speed envelope. The predicted maximum altitude is the lowest of:

- Maximum certified altitude.
- Altitude at which sufficient thrust is available to provide a specific rate of climb (normally 100 fpm).
- Altitude at which a specific minimum maneuver margin exists prior to buffet onset (normally 0.3g for CAA/JAA operation).

This does not guarantee the capability to operate at that altitude. Although each of these limits are checked by the FMC, thrust limitations may limit the ability to accomplish anything other than relatively minor maneuvering. At, or near the FMC maximum altitude, **it is possible for LNAV inputs to exceed the capability of the aircraft**. This could result in loss of altitude or airspeed.

Fuel predictions may be inaccurate at or above the maximum altitude and are not displayed on the CDU. Fuel burn-off at or above maximum altitude will increase significantly. Flight at this altitude should not be attempted.

Navigation

Fix-to-Fix direct navigation should be requested and utilized whenever possible. This, combined with the use of FMC ECON CRUISE, will result in the most economical cruise profile. Substantial deviations from flight planned altitudes and/or airspeeds due to weather or ATC, etc., should be analyzed with a combination of computer information, conventional fuel planning, buffet boundaries, etc.

Ideally, an END OF DESCENT POINT within the terminal area of the destination airport, including speed and altitude, should be inserted while at cruise. All expected descent profile information should be programmed at cruise altitude so as to minimize low altitude programming.

Cruise Speed Determination

Cruise speed is automatically computed by the FMC and displayed on the CRZ and PROGRESS 1/2 pages. It is also displayed by the command speed bug on the PFD when VNAV is engaged. The default cruise speed mode is economy (ECON) cruise. The pilot can also select long range cruise (LRC), engine out (E/O) modes, or overwrite fixed Mach or CAS values on the CRZ page target speed line.

ECON cruise is a variable speed schedule that is a function of gross weight, cruise altitude, cost index, and wind component. It provides the lowest cost cruise operation, but may not be appropriate for use where a fixed Mach number is required (i.e. NAT tracks). Continental uses either a fixed Mach schedule or LRC for flight plans. The use of ECON cruise may give results that differ from computer flight plans. However, Continental has chosen a cost index of 180 which approximates LRC. Entry of zero for cost index results in maximum range cruise. Cost index entries up to 9999 are allowed. However, thrust limits or maximum speed limits will generally be encountered with cost index entries of 5000 or more. If the cruise speed calculated is near the maximum speed limit, transient wind conditions may cause exceedances of the limit. In this case, use speed intervention as necessary to decrease airspeed to prevent exceedances.

Headwinds will increase the ECON CRZ speed. Tailwinds will decrease ECON CRZ speed, but not below the zero wind maximum range cruise airspeed.

LRC is a variable speed schedule providing fuel mileage one percent less than the maximum available. No wind corrections are applied to LRC. The ENG OUT cruise speed produces an LRC schedule for engine out operation.

Required Time of Arrival (RTA) speed is generated to meet a time required at an RTA specified waypoint on the FMC LEGS page.

Cruise Performance Economy

The dispatch computed fuel burn from departure to destination is based on certain assumed conditions, i.e., takeoff gross weight, cruise altitude, route of flight, temperature, wind enroute, and cruise speed. The planned fuel burn can increase due to:

- Temperature above planned
- A lower cruise altitude than planned
- More than 2,000 feet above optimum altitude
- Speed faster than planned, or appreciably slower than long-range cruise if planned for long-range cruise
- Stronger headwind component
- Unbalanced fuel
- Improperly trimmed aircraft
- Excessive thrust lever adjustments

Cruise fuel penalties include:

- ISA + 10°C: 1% increase in trip fuel
- 2,000 feet above optimum altitude, 1 to 2% increase in trip fuel
- 4,000 feet below optimum altitude, 4 to 5% increase in trip fuel
- 8,000 feet below optimum altitude, 12 to 14% increase in trip fuel
- Cruise speed M.01 above schedule, 1 to 2% increase in trip fuel

Fuel Management

When established in cruise, the crew should verify that the fuel remaining on board meets or exceeds all requirements for a safe completion of the flight. This can be done via FMC forecast of fuel on board at destination compared to flight plan fuel estimates. Fuel verification should occur periodically throughout the flight.

Note: To ensure accurate forecast fuel at destination, all significant winds aloft information should be entered on the RTE DATA page.

Center Tank Fuel

During taxi, takeoff, climb and cruise all fuel pumps should be on and both crossfeeds closed. In this configuration, both engines are being pressure fed from the center tank. As the center tank quantity decreases to near empty the **FUEL LOW CENTER** EICAS advisory message is displayed. Push **CENTER FUEL PUMP** switches OFF. The engines will now be pressure fed from the left and right main tanks.

Fuel For Enroute Climb

The additional fuel required for a 4,000 foot enroute climb is approximately 500 to 1,000 pounds (depending on the gross weight). This additional fuel is offset by the savings in the additional descent. It is usually beneficial to climb to a higher altitude if recommended by the FMC or the flight plan, provided the wind information used is reliable.

Fuel Temperature

Extended operations at high cruise altitudes tends to lower fuel temperature. Fuel temperature will tend to change toward total air temperature. In some cases the fuel temperature may approach the fuel freeze temperature.

Fuel freeze should not be confused with fuel ice caused by frozen water particles. Fuel freeze is caused by the formation of wax crystals suspended in the fuel, which can accumulate below the freeze point. Fuel tank temperature should be maintained at least 3°C above the freezing point of the fuel being used (see Section 1 LIMITATIONS).

Maintaining a minimum fuel temperature should not be a concern unless the fuel temperature lowers to within a few degrees of that limit. The rate of cooling of the fuel is approximately 3°C/hour, with a maximum of 12°C/hour possible under the most extreme cold-day conditions.

Fuel temperature will tend to change toward total air temperature. If the total air temperature is lower, it may be increased to raise the fuel temperature.

Total air temperature can be raised by:

- Deviating to a warmer air mass
- Increasing Mach number

It may take up to an hour to stabilize the fuel temperature. In most cases, the required descent would be within 3,000 to 5,000' below optimum altitude. In the more severe cases, a descent to altitudes of 25,000' to 30,000' might be required. An increase of .01 Mach will result in an increase of 0.5°C to 0.7°C total air temperature.

High Altitude / High Speed Flight Characteristics

The aircraft exhibits excellent stability throughout the high altitude/Mach range.

Mach buffet is not normally encountered at high Mach cruise, even at M_{MO} .

The aircraft does not have a Mach tuck tendency.

As speed nears M_{MO} , drag increases rapidly. Consequently at high weights, sufficient thrust is not available to accelerate to M_{MO} in level flight at high cruising altitudes.

During turbulent flight conditions, it is possible to experience high altitude g buffet at speeds less than M_{MO} . The controls are fully effective at all times.

Trim Technique

If an out-of-trim condition is suspected, check engine parameters for indication of unequal thrust. Trimming the aircraft to counteract this condition results in further increase in drag with its resultant loss of fuel mileage. Set and maintain a balanced thrust condition. Zero the aileron and rudder trim. Do not disconnect the autopilot to trim the aircraft.

VNAV OPERATION - CRUISE

VNAV transitions to the cruise phase when reaching the top of climb (T/C) point, defined by the cruise altitude entered in the FMC during preflight, and continues until reaching the top of descent (T/D) point.

The VNAV CRZ page provides access to the parameters defining the cruise phase; and is used to evaluate, monitor, and modify the cruise altitude, speed, and step climb. It also displays time and distance to T/D point (also on PROG page 1/3), and provides access to engine out performance data. The VNAV CRZ page is the default VNAV page displayed when the VNAV function key is selected prior to reaching T/D (VNAV operating in cruise phase).

FMA ANNUNCIATIONS

The FMA AUTOTHROTTLE and PITCH mode annunciation during the VNAV cruise phase is:

SPD and **VNAV PTH**

CHANGING CRUISE ALTITUDE

If ATC assigns or the pilot requests a final altitude that is below the initial cruise altitude, this new altitude should be entered on the CRZ ALT line of the VNAV ACT 250KT / ECON CLB page. This permits VNAV to transition to the Cruise phase of flight when the aircraft reaches this altitude. The initially entered cruise altitude must be attained or changed, or the FMC does not transition to the Cruise phase.

Note: When the FMA pitch mode is **VNAV ALT** (aircraft level at an altitude lower than FMC cruise altitude), and the pilot lowers the cruise altitude on the VNAV ACT 250KT / ECON CLB page, the MCP altitude knob must be pushed to change the FMA pitch mode to **VNAV PTH**.

If the new altitude is above the initial cruise altitude, all that is required is to set this altitude in the MCP altitude window and press the MCP altitude knob (altitude intervention). The cruise altitude in the FMC is automatically updated to the new altitude.

Once the cruise altitude is attained (**VNAV PTH**), MCP altitude intervention higher or lower automatically updates the FMC cruise altitude (cruise climb and cruise descent). This allows the crew to raise or lower the current altitude without using the CDU, and without confirmation by having to use the EXEC key.

STEP CLIMBS

If the Continental flight plan does not show more than one altitude on the climb profile, or if the flight planned / optimum step climbs are not made, the ICAO STEP SIZE should be zeroed out on the PERF INIT page (ground only) or the VNAV CRZ page in flight. The FMC performance predictions assume the pilot has initiated all planned or optimum step climbs.

Continental flight plans use a cost index number (entered in the **COST INDEX** prompts on the PERF INIT page during preflight) that closely matches LRC. The step climb profile on the flight plan is accomplished at flight plan fixes / waypoints or distance and time from these fixes / waypoints. The cost index used for the FMC ICAO generated step climb calculations only considers crew, maintenance, and fuel costs.

If the actual aircraft weight (ACCULOAD) is close to the flight planned aircraft weight the pilot should use planned step climbs (normally preferred method). This allows the pilot to specify step altitudes at a flight plan fix / waypoint. A planned step climb is made on the ACT RTE LEGS page by entering the step altitude followed by "S" (390S) adjacent to the desired step point. When using the flight plan step climbs the ICAO STEP SIZE should be zeroed out.

Optimum step climbs use FMC computed altitude step points based on the entered step size. The ICAO standard is 4000 ft. To compare the FMC step point to the flight plan step point, the pilot may change the ICAO STEP SIZE to a step altitude that more closely matches the flight plan step altitudes. Step sizes are entered as a 4 digit multiple of 1000 ft, up to a maximum of 9000 ft.

The FMC computed altitude step point, displayed as **S/C** on the ND, is the position along the route at which the VNAV cruise climb should begin. No step climbs are predicted within 200 nm of T/D.

To execute a step climb, set the step altitude in the MCP altitude window and press the altitude selector knob. (This automatically resets the CRZ ALT on the VNAV CRZ page). The FMC enters a VNAV cruise climb (ACT CRZ CLB) to the step altitude. No step climbs are accomplished without pilot action.

DESCENT

A good descent profile takes into consideration many variables and can account for significant fuel savings.

Maintaining the desired descent profile and utilizing the ND map mode to maintain awareness of position will ensure a more efficient operation. The crew should be aware of the destination weather and traffic situation and consider the requirements of a potential diversion. A review of the airport approach charts and pages, and a briefing for the approach and landing will be conducted. Complete this approach briefing as soon as practical, preferably before arriving at top of descent so the crew may give full attention to aircraft control.

The VNAV PATH descent should be used whenever possible. Early descents, should be initiated using Altitude Intervention on the MCP. This will result in a Cruise descent if initiated beyond 50 miles from T/D and a DES NOW descent if initiated within 50 miles of the T/D. Flight deck workload increases as the aircraft descends into the terminal area. Distractions must be minimized, administrative and nonessential duties completed before descent or postponed until after landing. The earlier that essential duties can be performed, the more time will be available for the more critical approach and landing phases. Below 10,000' MSL, limit programming of the FMC to minimize pilot head-down time.

Traffic considerations and speed control at specific airports frequently prevent execution of an ideal descent at best economy speeds. In these cases, the pilot should adjust his/her descent point so that an idle power descent is accomplished.

Enroute Descent (VNAV)

The normal FMC descent speed schedule consists of a descent from cruise altitude to the speed transition altitude, followed by a descent at ten knots less than the transition speed stored in the navigation data base for the arrival airport. The speed schedule is adjusted to accommodate waypoint speed/altitude constraints entered on LEGS pages. If desired, the descent speed schedule can be overwritten by Mach, Mach/IAS, or IAS values on the DES page target speed line. If the FMC information is not available, use Mach .84/310 knots for best average fuel economy descent.

Descent Path

An FMC path descent provides the most economical descent method. It is necessary to enter at least one waypoint-related altitude constraint below cruise altitude on a LEGS page to generate a descent guidance path. The path will be built from the lowest constraint upward, assuming minimum idle thrust, or approach idle below the anti-ice altitude entered on the DES FORECAST page.

The path will be based on the descent speed schedule, and will accommodate all entered speed/altitude constraints. The path will reflect the effect of descent wind values entered on the DES FORECASTS page.

Use of DES DIR will delete all constraints from the LEGS page down to the altitude set in the mode control panel.

Caution: If a V_{NAV} mode is not engaged during the descent, or disengages, all hard altitude constraints must be set in the MCP altitude window.

Shallow vertical path segments may result in the autothrottle supplying partial power to maintain the target speed. Vertical path segments steeper than an idle descent may require the use of speedbrake for speed control. Deceleration requirements below cruise altitude (such as at 10,000' MSL) are accomplished based on a rate of descent of approximately 500 fpm. When a deceleration is required at top of descent, it will be performed in level flight.

Descent Constraints

Descent constraints may be automatically entered in the route when selecting an arrival procedure, or manually entered through an FMC CDU entry. Each push of the MCP altitude selector knob deletes the next waypoint altitude constraint between the airplane altitude and the altitude window. When initiating a descent with multiple descent altitude constraints the lowest cleared altitude will be set in the MCP altitude window.

Speed Intervention

VNAV speed intervention can be used to respond to ATC speed change requirements. **VNAV SPD** pitch mode will respond to speed intervention by changing aircraft pitch. The AFDS maintains the FMC speed displayed on the PFD airspeed indicator and/or the CDU CLIMB OR DESCENT pages. If speed intervention is selected, the MCP IAS/MACH selector is used to manually select the speed. The aircraft will now deviate from the pre-calculated VNAV path.

Caution: Speed Intervention in other than the VNAV approach phase does not insure that the aircraft will remain on the VNAV path.

Offpath Descent

The LEGS pages should reflect the planned arrival procedure. If a published arrival procedure is required for reference while being radar vectored, or the arrival is momentarily interrupted by a heading vector from ATC, the offpath descent circles provide a good planning tool to determine drag and thrust requirements for the descent.

The outer circle is referenced to the end of descent point, using a clean configuration and a direct path from the aircraft position to the end of descent waypoint constraint. The inner circle is referenced to the end of descent point using speedbrake. A separate waypoint may be entered on the OFFPATH DES page as a reference for the descent circles.

Both circles assume normal descent speed schedules, including deceleration at transition altitude, but do not include waypoint speed and altitude constraints.

Enroute Descent (Non VNAV)

Due to the low drag of the advanced technology wing, proper descent planning is necessary to arrive at the desired altitude at proper speed and configuration. The distance required for the descent is approximately 3 NM/1000' of altitude loss for no-wind conditions using ECON speed. Rate of descent is dependent upon thrust, drag, airspeed and gross weight.

In addition, excess airspeed is slow to dissipate and generally requires a level flight segment.

If the descent speed information is not available from the FMC, use Mach .84/310 for minimum fuel burn. Use Mach .82/280, 270 knots below 25,000' and 250 below 10,000' for turbulent air penetration.

The approximate descent rates available below 20,000' with idle thrust, clean or with speedbrakes are:

Target Speed	Rate of Descent	
	Clean	With Speedbrake
310 knots / .84 Mach	2300 fpm	5500 fpm
250 knots	1400 fpm	3500 fpm
Clean Min Man	1100 fpm	2400 fpm

Normally, descend with idle thrust in clean configuration (no speedbrake). Maintain cruise altitude until the proper distance or time from the planned descent point, and then hold the selected airspeed schedule during descent. Plan the descent to arrive at traffic pattern altitude at flaps up maneuvering speed about 12 miles out when proceeding straight-in, or about 8 miles out when making an abeam approach. A good crosscheck is to be at 10,000' AGL, not later than 30 miles from the airport, with a speed of 250 knots.

Losing airspeed can be difficult and may require a level flight segment. For planning purposes, it requires approximately 1 nautical mile per ten knots of airspeed to decelerate from 310 to 250 knots in level flight without speedbrake.

At 250 knots it requires an additional 4 NM to decelerate to flaps up maneuvering speed at average gross weights.

Speedbrake and Thrust Usage

While using the speedbrake during descent, allow sufficient margin in altitude and/or airspeed so that a smooth level off can be accomplished while lowering speedbrake and adding thrust without causing passenger discomfort or overshooting the desired altitude. Lower the speedbrake before adding thrust.

The use of speedbrake with landing flaps extended is not prohibited. If circumstances, such as descent in icing conditions, dictate the use of speedbrake with flaps extended, high sink rates during the approach should be avoided. Retract speedbrake below 1000 AGL.

An EICAS **SPEEDBRAKE EXTENDED** message occurs if speedbrakes are extended when either flaps are in the landing position (25, 30), radio altitude is 800' or below, or the thrust levers are not closed.

Caution: Landing with speedbrake extended will result in aft fuselage contact with the runway (tailstrike).

Landing Gear

Normal descents are made in the clean configuration to pattern or instrument approach altitude. If greater descent rates are desired, extend the speedbrake. When thrust requirements for anti-icing result in less than normal descent rates with speedbrake extended, or if higher than normal descent rates are required by ATC clearance, the landing gear can be lowered to increase the rate of descent.

Avoid using the landing gear for drag above 200 knots. This will minimize passenger discomfort and increase gear door life.

VNAV OPERATION - DESCENT

The VNAV descent phase of flight begins when the aircraft departs the CRZ ALT at the T/D, or begins the deceleration / acceleration (for descent speeds lower / higher than the cruise speed) segment prior to reaching the T/D. The descent phase continues until the first fix on the selected approach (XXXX INTG at 6R on the DEP/ARR page).

The VNAV DES page provides access to the parameters defining the descent phase, and is used to evaluate, monitor and modify the descent path. It also provides access to the OFFPATH DES and descent FORECAST pages. The VNAV DES page is the default VNAV page displayed when the VNAV function key is selected after T/D.

INITIAL DESCENT

The descent path can be one of two types: an ECON descent, or a SEL SPD descent. Continental uses the SEL SPD descent by entering the flight plan descent speed on the VNAV DES page during preflight. In either case, the path is based on idle power and is subject to all defined airspeed / altitude constraints.

For VNAV to operate successfully it must be understood that upon receiving an ATC clearance to descend to an altitude, or on a STAR profile descent, the PF must set the assigned altitude, or the lowest altitude for the profile, in the MCP altitude window. This allows VNAV to descend to the assigned altitude, or fly the CDU altitude profile that matches the STAR profile, when the aircraft reaches the T/D.

VNAV descents are not necessary prior to the T/D unless requested by ATC. If the MCP altitude is not set to a lower altitude by two minutes prior to the T/D, the FMC message **RESET MCP ALT** displays in the scratch pad.

EARLY DESCENTS

An early descent is any descent initiated prior to the T/D point. There are two types of descents that occur prior to T/D: a "Cruise Descent," and a "Descend Now."

Both descents are identical in terms of initial descent parameters; they differ only in their effect on the existing descent path. The initial parameters are:

- Rate of descent: approx 1,250 fpm
- Autothrottles: initially **THR** until approx 1,250 fpm, then **HOLD** (allowing the pilot to adjust the rate of descent as necessary)

Cruise Descent

A Cruise Descent is normally accomplished simply by setting the assigned lower altitude in the MCP altitude window and pushing the selector knob when more than 50 nm from T/D.

The following actions occur automatically:

- The aircraft begins a cruise descent at the speed on the VNAV CRZ page. (VNAV still in cruise phase of flight.)
- The CRZ ALT on the VNAV CRZ page is automatically updated to the MCP altitude.

Note: If ATC issues a lower altitude prior to reaching the initially assigned altitude, to prevent capturing the initial altitude the MCP altitude knob must be pressed again after entering the lower altitude (updates the FMC CRZ ALT to lower altitude).

- A new VNAV path, with a new T/D point, is built by the FMC.

CAUTION: If the assigned altitude is below 10,000 ft, the 240/10000 SPD TRANS line on the VNAV DES page is deleted and the aircraft descends at the cruise speed to the assigned altitude.

Note: When a Cruise Descent is initiated in relatively close proximity to the T/D, the pilot should monitor the indications on the ND. The cruise speed and shallow rate of descent make it possible to fly beyond the T/D prior to reaching the MCP altitude. (Indicated on the ND by the position of the green arc beyond the T/D point.)

Note: When inside 50 nm a Cruise Descent may also be accomplished by resetting the MCP altitude to the assigned lower altitude, changing the CRZ ALT on the VNAV CRZ page, and executing.

FMA annunciations are:

- Autothrottle: **THR** then **HOLD**
- Pitch: **VNAV SPD** then **VNAV PTH** when at new altitude.

Descend Now

A Descent Now may be initiated in either one of two ways:

1. When within 50 nm of T/D set the assigned lower altitude in the MCP window and push the selector knob, or
2. Set the assigned lower altitude in the MCP window and select DES NOW at 6R on the VNAV DES page. (Selecting DES NOW always initiates a Descent Now, regardless of proximity to the T/D point.)

The following actions occur automatically:

- VNAV changes from the cruise phase of flight to the descent phase (VNAV DES page active).
- The aircraft begins a descent at the speed on the VNAV DES page.

The aircraft merely cuts the corner below the original T/D and intercepts the existing VNAV path.

FMA annunciations are:

- Autothrottle: **THR** then **HOLD**. When the VNAV path is intercepted the autothrottles retard to idle to comply with the idle descent path (**IDLE** then **HOLD**).
- Pitch: **VNAV SPD** then **VNAV PTH** (or **VNAV ALT** if MCP altitude captured first, then **VNAV PTH** when the path is intercepted).

RULE OF THUMB: Descents prior to the T/D should normally be accomplished using the MCP altitude selector knob. This automatically initiates either a Cruise Descent (if greater than 50 nm of T/D), or a Descent Now (if within 50 nm of T/D). Use of the DES NOW prompt on the DES page is not recommended as it inhibits FMC updating of the destination fuel and ETA calculations until the VNAV path is captured.

Note: When initiating an early descent (Cruise or Descent Now) the autothrottles always initially indicate **THR** until approx 1,250 fpm is attained, then **HOLD**.

This can create a problem when reinitiating a descent after an interim altitude is captured (**VNAV ALT**). Resetting the MCP altitude window and pressing the knob removes the altitude restriction; however, VNAV sees it as the initiation of a descent. The autothrottles again indicate **THR** until the descent rate is reduced to approx 1,250 fpm, before going to **HOLD**.

If a high descent rate is required consider FLCH or disengaging the autothrottles.

LATE DESCENT

If ATC delays the descent until after passing the T/D point, or a lower altitude is not set in the MCP altitude window prior to T/D, the FMA pitch mode changes from **VNAV PTH** to **VNAV ALT**. This is a late descent, and is accomplished by setting a lower altitude in the MCP altitude window and pushing the selector knob. The pitch mode changes from **VNAV ALT** to **VNAV SPD** and the autothrottles go into the **IDLE** mode, then **HOLD**. It may be necessary to use speedbrakes to recapture the VNAV path descent profile. When the path is captured the FMA pitch mode is **VNAV PTH**.

FLYING THE PATH

VNAV path descents are accomplished at idle thrust.

When descending on the VNAV path the pilot must always be aware of the FMA pitch mode. If the FMA indicates **VNAV PTH** during descent the aircraft is on the path or has captured an altitude constraint on the CDU.

The VNAV Path Deviation Scale (VPDS) and pointer is a useful tool to aid the pilot in flying the VNAV path when the FMA pitch mode is **VNAV SPD**. When the VPDS is centered and the pitch mode is **VNAV SPD** the aircraft is flying airspeed and ignoring the path.

Headwinds

If the airspeed becomes more than 15 kts slow, the autothrottle mode changes to **SPD** and increases speed to the SEL SPD on the VNAV DES page. The FMA pitch mode remains **VNAV PTH**. (In level flight, at a CDU altitude constraint in **VNAV PTH**, the airspeed is allowed to slow 15 kts below the SEL SPD.)

Tailwinds

Above Transition Altitude

If the airspeed increases greater than 314 kts, (15 kts below V_{MO}) the scratch pad message **DRAG REQUIRED** displays. The aircraft may accelerate up to 15 kts above the speed on the SEL SPD line (max 319 kts, - 10 kts below V_{MO}), to maintain the path. If further correction is required, VNAV may allow the aircraft to rise up to 150 ft above the path to stop the acceleration.

If VNAV can no longer maintain the aircraft within 150 ft of the path, speed reversion occurs and the FMA pitch mode changes from **VNAV PTH** to **VNAV SPD**.

Below Transition Altitude

If airspeed increases greater than 10 kts above target speed, (240/10000), the scratch pad message **DRAG REQUIRED** displays. The aircraft may accelerate up to 15 kts above the target speed (maximum speed increase allowed is 5 kts above the transition speed, or 5 kts below the limit speed). If further correction is required, VNAV may allow the aircraft to rise up to 150 ft above the path to stop the acceleration.

If VNAV can no longer maintain the aircraft within 150 ft of the path, speed reversion occurs and the FMA pitch mode changes from **VNAV PTH** to **VNAV SPD**. VNAV resets the target speed to 240 kts, and the **DRAG REQUIRED** message displays again.

Note: The PF is responsible for airspeed control of ± 5 kts of the FMC or pilot selected airspeed. The use of speedbrakes is the most common method of maintaining the path with a tailwind.

SPEED RESTRICTIONS

The VNAV DES page should be used to change ATC airspeed restrictions by entering the assigned speed on the SEL SPD line. The FMA pitch mode changes to **VNAV SPD** as the aircraft momentarily ignores the VNAV path to make the speed adjustment then adjust pitch to return to the path. Speedbrakes should be used to aid in slowing to the new speed and recapturing the path.

Speed intervention may also be used to comply with ATC speed restrictions. Any time the MCP speed window is open during the VNAV descent phase the pitch is controlling airspeed and ignoring the VNAV path. The FMA pitch mode is **VNAV SPD** and the aircraft descends to the MCP altitude at idle thrust. Speed intervention should be used when the aircraft does not descend because VNAV is controlling to a CDU altitude, and the distance is such that the descent rate required is minimal if any. During speed intervention it is possible that the airspeed may become 5 – 15 kts slow before the autothrottles increase thrust.

SPEED / ALTITUDE RESTRICTIONS

An ATC speed / altitude constraint that is not a waypoint constraint must be entered on the VNAV DES page at the SPD RESTR line. VNAV computes a deceleration point to be on speed at the altitude.

Speed / altitude constraints at waypoints are entered on the LEGS page. VNAV computes a deceleration point to be on speed and at the altitude entered on the LEGS page. The VNAV DES page also displays the speed and altitude constraint that VNAV is using for control.

Note: Any time a speed and/or altitude constraint is made on the LEGS page the FMC computes a new VNAV descent path to include the new constraint. The VPDS is temporarily removed and reappears when the FMC has calculated the new path. Depending upon how the path was altered the pilot may have to take action to reacquire the VNAV path.

If given approval for a high speed descent below 10,000 ft, delete the SPD TRANS line on the VNAV DES page.

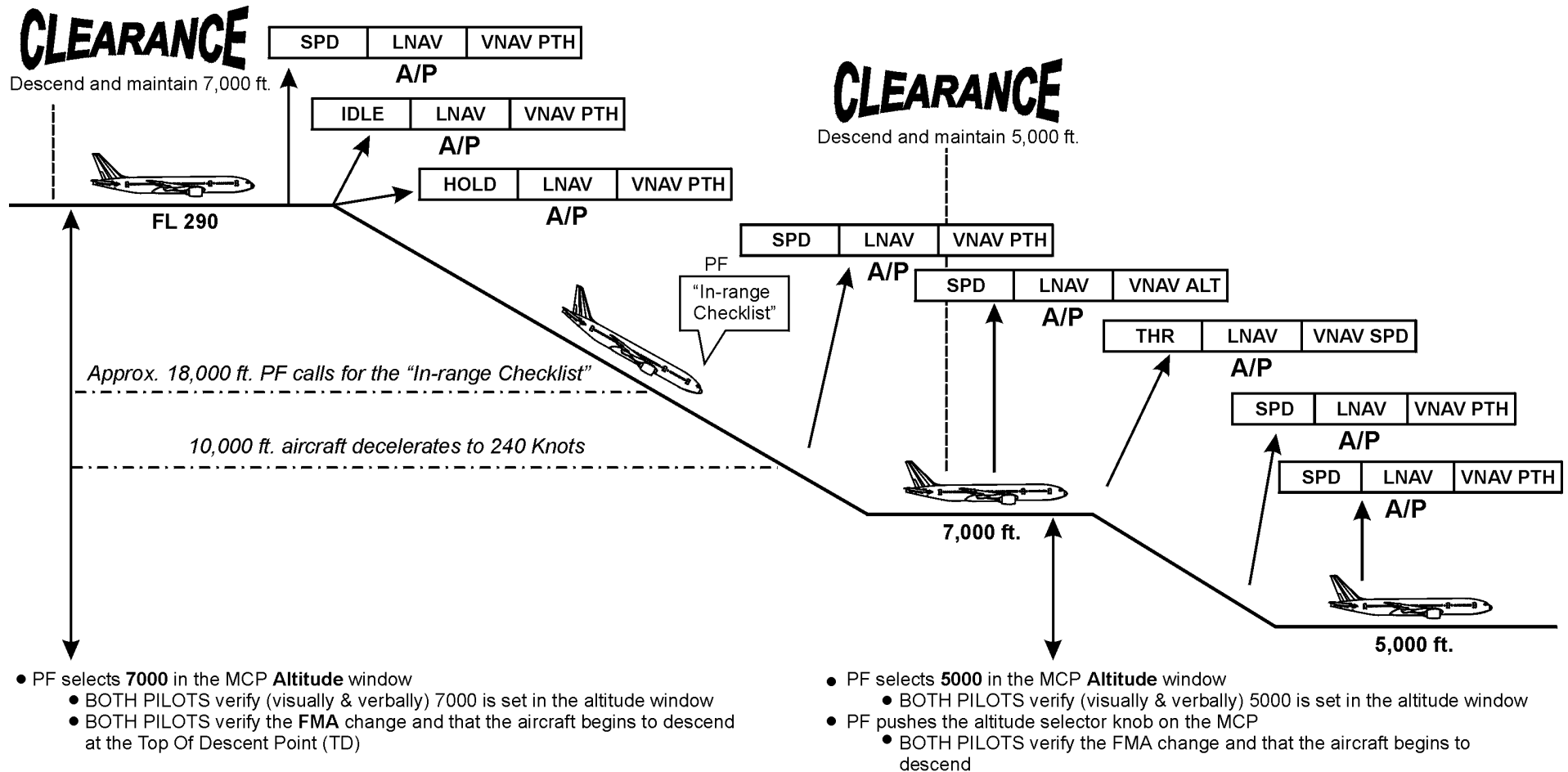
DELETING ALTITUDE RESTRICTIONS

Any time an altitude constraint exists between the current altitude and the E/D, a **DES DIR** prompt is displayed at 6R on the VNAV DES page. Selecting and executing the DES DIR function deletes all altitude constraints down to, but not including the altitude set on the MCP and, if not already in a descent, initiates a descent to the MCP altitude.

Altitude intervention may also be used to delete altitude constraints. Once in a descent each push of the altitude selector knob deletes one altitude constraint down to, but not including the MCP altitude.

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Descents with Vertical Navigation (VNAV PTH)



NOTES: 1. If the clearance altitude is set in the MCP the aircraft will automatically begin a **VNAV PTH** descent at the Top Of Descent Point (TD).
 2. 5000 is an FMC CDU LEGS page altitude constraint.

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HOLDING

During selection of the holding pattern in the FMC, verify proper holding pattern direction and inbound course is entered.

Begin speed reduction within 3 minutes prior to estimated arrival at the fix so as to arrive at the holding fix at or below the maximum authorized holding speed for the altitude.

Upon arrival at the fix, maintain holding speed and hold as instructed. Maintain the last assigned altitude/flight level.

Make all turns during entry and while holding at 30° bank angle, or 25° bank angle using the flight director system. If holding using LNAV, the FMC will determine the bank angle.

Compensate for known effect of wind, except when turning.

Advise ATC immediately if an increase in airspeed is necessary due to turbulence, or if unable to accomplish any part of the holding procedures.

Configurations

Above 14,000 feet - Hold clean and use holding chart speed, but not above FAA maximum speeds without ATC approval.

At or Below 14,000 feet - Extensive holds should be made in the clean configuration. When expected approach time or altitude to which cleared indicates that an approach clearance is imminent, flaps should be extended and airspeed reduced as required.

Maximum Airspeeds (FAA / ICAO Standard)

Altitude	Speed	Time
MHA - 6000 MSL	200K IAS	1 Min
Above 6000 MSL - 14,000 MSL	230K IAS *	1 Min
Above 14,000 MSL	265K IAS	1 1/2 MIN

* 210K where published.

Holding airspeeds at international destinations may be further limited by State Regulations. Refer to the Jeppesen STATE RULES AND PROCEDURES for specific holding speeds at foreign destinations.

Timing

Timing of the initial outbound leg should be 1 minute at or below 14,000' MSL, and 1 1/2 minutes above 14,000' MSL. Timing for subsequent outbound legs should be adjusted as necessary to achieve proper inbound leg time.

In extreme wind conditions or at high selected holding speeds, the aircraft may exceed the defined holding pattern protected airspace; however, the holding pattern depicted on the ND will not exceed the limits. Advise ATC if an increase in airspeed is necessary due to turbulence, if unable to accomplish any part of the holding procedure, or if unable to comply with the speeds listed in the tables above.

Outbound timing begins abeam the fix. If the abeam position cannot be determined, start timing when the turn to the outbound heading is complete and the wings are level.

The time required to complete a 180° turn will vary with weight, altitude, and speed. Example: At 5,000' and 200 knots, it will take approximately 1¼ minutes. At 20,000' and 230 knots, it will take approximately 1½ minutes.

Plan the holding pattern so as to arrive at the holding fix at the correct time to meet EFC requirements.

Standard Pattern

Parallel Entry - Parallel holding course, turn left, and return to holding fix or intercept holding course.

Teardrop Entry - Proceed on an outbound track of 30° (to the holding course) for 45 seconds, then turn right to intercept the holding course.

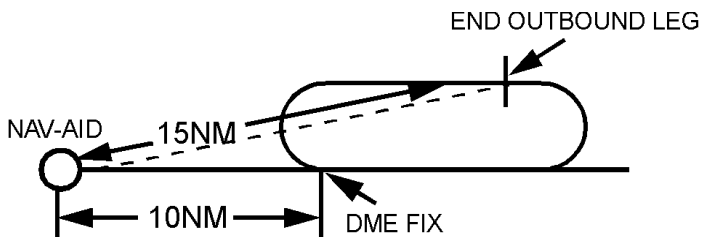
Direct Entry - Turn right and fly the pattern.

Recommended method for determining entry - Put tail of course needle on outbound course (holding radial).

Ensure proper inbound holding course is entered in FMC.

DME Holding

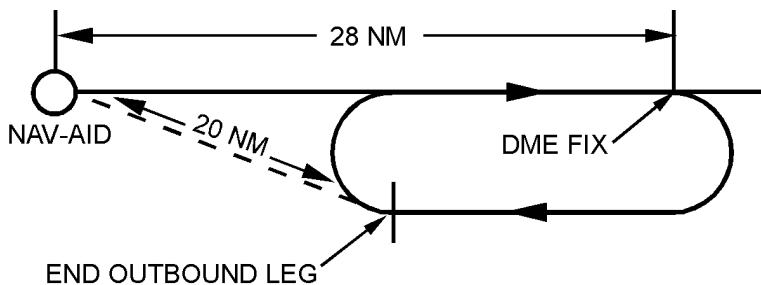
Example #1 - Inbound to the VOR hold east of the 10-mile DME fix on the 090 degrees radial, 5 mile legs, right turns.



7574210B

Since the inbound course is toward the navaid, the fix distance is 10 NM and the leg length is 5 NM. The end of the outbound leg will be reached when the DME reads 15 NM.

Example #2 - Outbound from the VOR hold west of the 28 mile DME fix on the 090 degrees radial, 8 mile legs, right turns.



7574210A

Since the inbound course (to the fix) is away from the navaid, the fix distance is 28 NM and the leg length is 8 NM. The end of the outbound holding legs will be reached when the DME reads 20 NM.

VNAV OPERATION - HOLDING**CLIMB / CRUISE PHASE**

In the VNAV Climb or Cruise phase of flight, the FMC decelerates to the FMC/pilot entered holding speed prior to entering the hold.

Once the aircraft is established in the holding pattern speed changes may be made on the ACT RTE HOLD page SPD/TGT ALT line at 1R, the SEL SPD line on the CLB/CRZ/DES page, or by speed intervention.

DESCENT PHASE

In the VNAV Descent phase of flight, the FMC does not always decelerate prior to entering the hold. Deceleration only occurs when there is an altitude constraint (in large font) on the ACT RTE HOLD page SPD/TGT ALT line.

If the hold does not have an altitude constraint (large font) the pilot must manually enter one on the ACT RTE HOLD page SPD/TGT ALT line, or the holding pattern fix on the ACT RTE LEGS page, for the FMC to command a deceleration prior to entering the hold. If the holding altitude has an "A" (at or above) after the altitude (i.e., 13000A), VNAV does not begin a deceleration until after passing the holding fix.

It may be necessary to change the airspeed on the VNAV DES page SPD SEL line after exiting a holding pattern in the descent phase of flight.

Note: The FMC commands deceleration when appropriate prior to entering the hold. If speed reduction 3 minutes prior to the holding fix is desired, the active VNAV (CLB / CRZ / DES) page SPD SEL line may be used to select and execute the holding speed. Speed intervention may also be used.

VNAV OPERATION - DIVERT

Diversions are defined as landing at an airport that is not the destination airport.

The preferred method for diverting is to use the CDU ALTN page. Access to this page is accomplished by several methods (RTE X, INIT/REF INDEX, FMC COM); the simplest is to push the ALTN function key on the CDU.

DIVERTING

The first step to any diversion is to ensure T/C has been reached, or change cruise altitude to aircraft altitude (FMA **VNAV PTH**).

After selection of the ALTN page, four alternate airports, sorted in order of ETA, are displayed. The airport at 1L is automatically selected (XXXX <A>). If the airport at 1L is not the desired diversion airport, select one of the other three airports (XXXX <SEL>), or enter another airport and then select the entered airport with the appropriate LSK. The automatically or manually selected airport identifier is displayed above the **DIVERT NOW** prompt at 6R.

The next step is to display the MOD XXXX ALTN page and define the routing to the airport. There are two ways to display this page:

1. Press a right side LSK, opposite the selected airport, or
2. Select the **DIVERT NOW** prompt at 6R then push the **ERASE** prompt at 6L.

Following either of these actions (#1 is preferred), the MOD XXXX ALTN page is displayed. Three choices of routing to the selected diversion airport are available to be selected:

- 1L **DIRECT TO <SEL>** The default routing. A direct route from present position to the selected alternate airport.
- 2L **L00 OFFSET** A left or right offset along the current active route.
- **OVERHEAD**
- 3L **XXXXX** Follows the current active route until over the specified waypoint (XXXXX), then heads directly to the selected alternate airport. The active waypoint on the LEGS page is the default OVERHEAD selection.

Note: The alternate page does not access the FMC database - it only looks at the active route. Any attempt to enter a waypoint at 3L (for the OVERHEAD option) that is not already in the active route results in the CDU scratch pad message **INVALID ENTRY**.

Therefore, to use the OVERHEAD option and comply with an ATC routing clearance not currently in the active route, the active route must first be modified.

For simplicity, the DIRECT TO option should be used if at all possible when diverting.

Note: If a route offset had been executed on the ACT RTE X page prior to diverting, it should be deleted before executing the **DIVERT NOW** prompt. If not, the route offset carries over to the alternate routing and can only be removed by executing a direct to function on the LEGS page.

Once the routing to the alternate airport is determined, selecting and executing the **DIVERT NOW** prompt at 6R accomplishes the following:

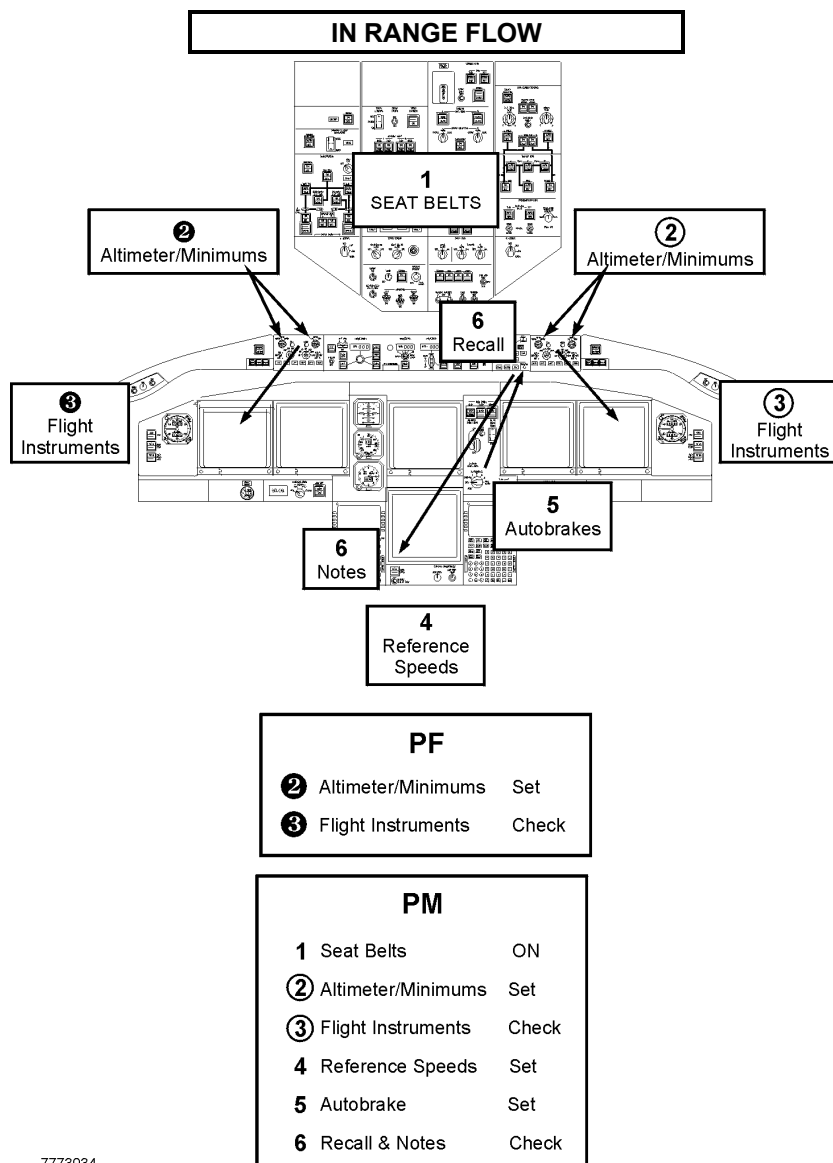
1. Changes the original route destination airport to the diversion airport.
2. Creates a route, as selected, on the ACT RTE X page from present position to the XXXX ALTN airport. (ETA and fuel remaining calculations are based on this route.)
3. Deletes descent constraints, if any. (Scratch pad message **DESCENT PATH DELETED** displayed when **DIVERT NOW** is executed.)
4. Configures the DEP/ARR page for the diversion airport arrivals and approaches.

Note: After a divert is executed, the XXXX ALTN page is not updated until all CDUs are selected off of the XXXX ALTN page. Also, the **.COMM** on the EICAS indicates an FMC message (**DIVERSION REPORT**) has been generated and needs to be completed.

Finally, define an end of descent point by either:

- Selecting an arrival / approach for the diversion airport, or
- Enter an altitude for the airport (i.e., airport field elevation), on the LEGS page.

This builds a VNAV descent path to the diversion airport and displays a T/D point on the ND (if not already beyond the T/D, as indicated by the appearance of the VPDS on the ND).



IN-RANGE

The Pilot Flying should call for the IN-RANGE Checklist at approximately 18,000 feet. For flights with cruise altitudes below 18,000 feet, the IN-RANGE Checklist should be called for at Top Of Descent.

Approximately 10 minutes before landing, the no smoking switch should be cycled once indicating that landing is imminent.

Note: Flight crewmembers are required to use the boom microphone below 18,000' MSL.

Meteorological conditions permitting, the use of landing lights, logo lights and strobe lights is required below 18,000'.

PM Challenge	IN-RANGE	PM Respond
Seat Belt Sign		ON
Altimeters & Flt Inst.....	SET, CHECKED (PM, PF)	
Reference Speeds	SET (PM, PF)	
Autobrake.....	SET	
Recall & Notes	CHECKED	
Arrival Briefing	COMPLETE	

PM Challenge**PM Respond**

Seat Belt Sign **ON**

Altimeters & Flt Instruments **SET & CHECKED (PM, PF)**

Set barometric pressure on all altimeters as required. Set appropriate BARO or RADIO minimums for the planned approach. If transition level is below 18,000 ft. MSL set barometric pressure on all altimeters when cleared to an altitude below the transition level.

On CAT I ILS or Non-Precision approaches, the BARO altimeter bug is the primary reference to DA or DDA. Set MINS reference, on EFIS control panel to BARO. DH on a CAT II ILS is determined solely from the RADIO or inner marker, as appropriate. AH (LAND 3) or DH (LAND 2) on CAT III approaches will be determined solely by reference to the RADIO bug. Set RADIO on MINS selector on EFIS control panel.

Set the Reference Altitude Bug on the altimeters as follows:

APPROACH TYPE	BARO ALTIMETER REF SET TO	RADIO ALTIMETER REF SET TO
CAT I	Published DA	N/A
CAT II	N/A	Published RA DH
CAT III	N/A	100' RA (LAND 3) AH 50' RA (LAND 2) DH
Non-Precision	DDA / DA	N/A
Visual	N/A	N/A

Cross check all flight instruments for indications and flags.

Reference Speeds SET (PM, PF)

Check APPROACH REF page displayed. Pressing the desired landing flap speed prompt causes the flap/speed to be down selected to the scratch pad.

Entering the flap/speed to line 4R transmits the computed V_{REF} for the current gross weight, to the Speed Tape. It is displayed as REF.

Airspeed Indicator bugs are displayed on the airspeed tape as follows:

MCP Selected Speed Bug - Set to target speed when landing flaps are selected.

Reference Airspeed Bugs – Bugs are displayed on the speed tape at $V_{REF}30 + 80$ (clean Min Man), $V_{REF}30 + 60$ (Flaps 1), and $V_{REF} 30 + 40$ (Flaps 5), $V_{REF}30 + 20$ (Flaps 15/20) and $V_{REF} 30$ (REF).

If the autothrottles are to be disengaged prior to landing, once landing flaps have been commanded, position the MCP selected speed bug to V_{REF} plus $\frac{1}{2}$ the reported headwind component and all of the gust, with the total adjustment not to exceed 20 knots. The minimum target speed is $V_{REF} + 5$.

Examples: Reported headwind 15 gusting to 20. Target setting is V_{REF} plus 12 knots.

Note: When the landing speed is adjusted by a non-normal checklist, the wind correction must be applied when not using autothrottle. For example, if the checklist states Use flaps 20 and $V_{REF} 30 + 20$ for landing, the MCP selected speed should be positioned to $V_{REF} 30 + 20 +$ wind correction (5 knots minimum up to 20 knots maximum).

Headwind additive can be estimated by using 50% for direct headwind, 35% for a 45° crosswind, zero for a direct crosswind, and interpolation in between. Use of PROGRESS 2/2 provides a quick reference to the headwind component. Do not apply wind corrections for tailwinds.

Note: When using autothrottle to land, position the MCP selected speed bug to $V_{REF} + 5$ knots, regardless of computed additive.

Autobrake..... SET

Note: For dry runways of 8000' or greater an autobrake setting of 3 and idle reverse is recommended. For runways less than 8000', that are not dry, an auto-brake setting of 3 or greater and reverse thrust as necessary is recommended. Significant carbon brake wear improvement is possible with brakes that are properly heated during the landing.

Note: For Category III operations an autobrake setting of 3 or greater and reverse thrust as necessary. Autobrakes 3 or greater is required to ensure compliance with the runway length requirements for Category III operations.

If operational, the use of autobrake for landing is required.

Note: The operational characteristics of carbon brakes allow efficient higher auto-brake settings or manual brake applications.

- 1 This setting will provide a moderate deceleration rate on dry, long runways with braking action GOOD.
- 2 or 3 This setting provides slightly greater deceleration, and is recommended on long runways (greater than 8000') suitable for most routine operations
- 4 These settings should be used when moderate deceleration rates are required for wet and slippery runways, when landing rollout distance is limited, for any landing requiring higher than normal landing speeds, and when braking action is POOR.
- MAX AUTO This setting should be used when maximum deceleration rates are required for minimum stop distance. The deceleration rate is less than produced by full manual braking. The MAX AUTO position will not be used for any normal landings on dry runways.

Recall & Notes..... CHECKED


The PM should press RECALL to check EICAS for any displayed messages, then cancel. NOTES are selectable, using the CCD, through the operational NOTES key at the bottom of the electronic checklist page.

Arrival Briefing COMPLETE

Arrival Briefing

The Captain will ensure an arrival briefing with the entire flight deck crew is completed. Only those items associated with the specific arrival need be addressed. This briefing should be accomplished at cruise altitude when the destination ATIS and/or arrival information becomes available. The intent is to complete as much of the review and briefing as possible at a time when the entire crew can collectively review the plan as opposed to trying to conduct a briefing during descent or on approach. If there are subsequent changes from what was briefed, such as runway changes, STARS, approaches, automation modes, etc., those items should be reviewed at an appropriate time consistent with workload. Refer to the **AUTOMATED FLIGHT OPERATIONS** section regarding coordination and programming of such changes.

The following **PILOT BRIEFING** guide provides a list of items that should be considered for review. The objective is to provide the crew with concise, factual information relative to the arrival. The briefing should be predicated on the assumption that flight crewmembers are well versed in standard operating procedures and as such, a comment of "Standard or SOP" is appropriate for those routine items that do not require further amplification. If any item is "not applicable" or is "not an issue," then it need not be specifically addressed in the briefing. By the same token, there may be additional special issues for the flight that, though not specifically listed, should nevertheless be addressed. The pilot who will be flying the arrival should brief those items associated with the procedure as defined by the **PILOT FLYING BRIEFS** items. Note items shown in gray color are not applicable to the **Arrival** briefing.



Rev 09/01/02 #1

PILOT BRIEFING

CRM

- Experience Level, Currency
- PF, PM, IRO Duties, Threat-Err Mgt

Departure or Arrival

- MEL, NOTAMs, Unique Issues
- Arpt Info (-7) & Taxi Plan (-9)
- WX, Rwy Cond, T/O or Ldg Wt
- RTO & Evac Issues
- Air Return, Fuel Jett, Altn
- **TERR** Considerations

PILOT FLYING BRIEFS

- SID or STAR & Approach
- Displays & Automation Modes
- Trans -ALT(dep) -LVL(arr)
- EO Spl Procedures / Accel Alt

ACM, Enrte Issues, PAs, Questions

Blue items briefed at beginning of trip or pilot change
 Black items briefed as required for each flight leg

Arrival

Although the chronological sequence is slightly different between departure and arrival phases of flight, nearly all the same items are appropriate to both briefings and the order in which they are reviewed is at the pilot's discretion.

- MEL, NOTAMs, Unique Issues

Review any inoperative or xMEL'd aircraft components, any NOTAMs with operational impact, and any other unique operational issues. Ensure the arrival station is aware of unique customer or aircraft requirements, such as an inoperative APU. Consider other items such as airport curfews, charter / ferry issues, maintenance verification / test flight requirements, crew legality, security issues, and any other factor that may effect the arrival phase of the flight.

- Airport Information (-7 page) and Taxi Plan (-9 page)

A comprehensive review of all general information on the -7 page(s) in addition to the appropriate ARRIVAL CONSIDERATIONS block. Review as necessary the anticipated taxi plan for arrival including hold short requirements, planned runway exit points, parallel runways operations, taxiway restrictions for size or weight, planned taxi route and parking gate / tow-in procedures.

- Weather / Runway Conditions / Landing Weight

A review of current weather for arrival including considerations for adverse weather operations on arrival such as necessity of engine / wing anti-ice, windshear, etc. Additionally review the planned runway, wind considerations, any braking action reports or performance limitation / penalties, and anticipated landing weight.

- Alternate

If required, review the destination alternate details including weather, anticipated routing / approach, and fuel burn.

- | |
|------|
| TERR |
|------|

 Considerations

WARNING: Prior to arrival at airports near mountainous or significant terrain the following procedures will be accomplished:

- All appropriate SIDS, STARS, approach charts, ENGINE FAILURE ON DEPARTURE / ONE ENGINE INOPERATIVE MISSED APPROACH procedures, and associated enroute charts for the departure and arrival will be reviewed and readily available.

- The flight crew will review all Grid MORAs, MEAs, MOCAs, AMAs to include position of high terrain along the departure / arrival route.
- For aircraft with enhanced GPWS, at least one pilot will have the TERR function selected. This feature should be considered for use even in day VMC conditions in order to assist in building a mental picture of the airport and surrounding terrain. If this feature is not installed, consider using radar to help identify prominent terrain features.

• **STAR & Approach Review (PILOT FLYING BRIEFS)**

Review the arrival and approach procedures, and confirm correct FMC programming for airspeeds, altitudes, routing, etc. On aircraft equipped, consideration should be given to programming the second possible arrival / approach into RTE 2 when multiple arrivals are in use. For approaches conducted in VMC conditions, the briefing may be abbreviated to include those items pertinent to the approach, and confirming all associated electronic nav aids have been correctly tuned. When conducting Monitored Approach procedures, the First Officer will brief the specific approach chart details and the Captain will brief the monitored approach procedures using the applicable PRECISION OR NON-PRECISION MONITORED APPROACH BRIEFING GUIDE. For the specific Instrument Approach, Terminal Arrival, or Charted Visual procedure, the following items should be reviewed:

- approach title and date
- nav aid frequencies
- courses
- FAF altitude
- approach minimums
- weather requirements
- approach / runway lighting systems
- missed approach / go around procedures
- transition level and associated notes
- LAHSO procedures if applicable
- any inoperative aircraft system affecting the approach or landing

• **Displays & Automation Modes (PILOT FLYING BRIEFS)**

Ensure the navigation display options selected are appropriate for the procedure and phase of flight, including scale, radar / TCAS / nav aid information displayed, and raw data as required. Review the automation modes to be used during the procedures (LNAV, VNAV, APP, A/P and A/T off/on, etc).

- Transition -LeVeL (arr) (**PILOT FLYING BRIEFS**)

Review the Jepp chart and cross check the FMC TRANS LVL value on the DES page (as installed) for arrival.

- Engine Out Special Procedures / Acceleration Altitude-Height (**PILOT FLYING BRIEFS**)

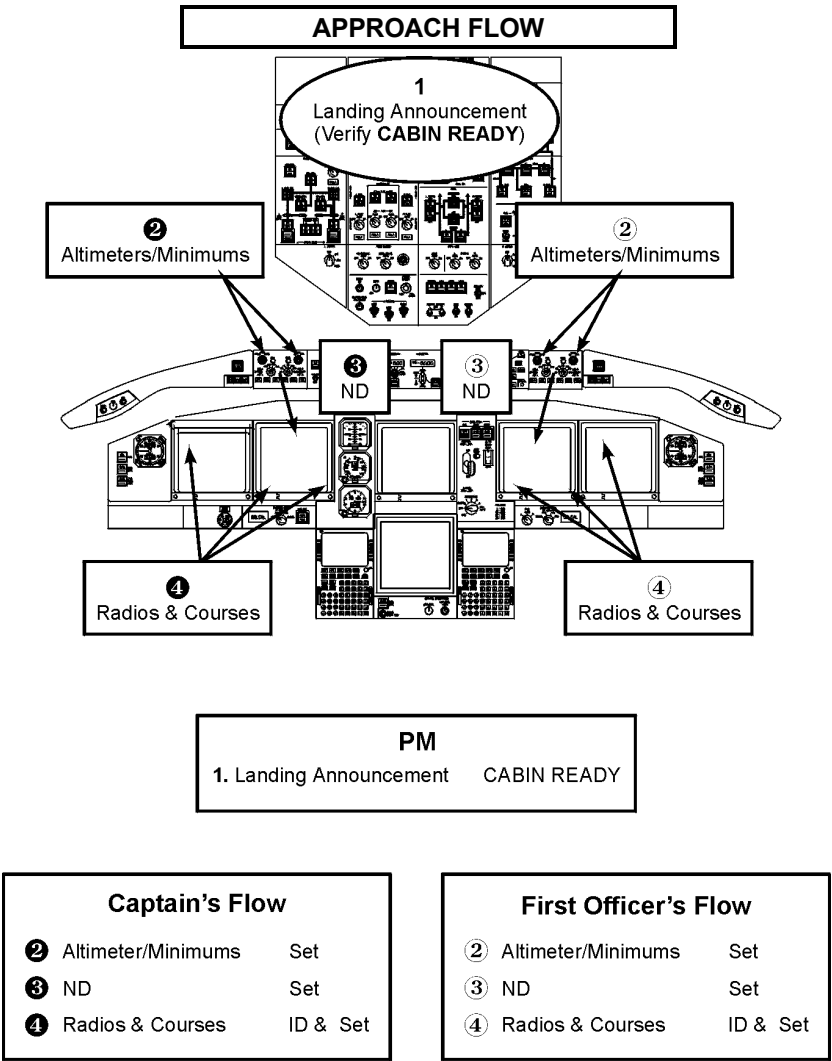
Review the specific –7 pages and procedures for ENGINE FAILURE ON DEPARTURE / ONE ENGINE INOPERATIVE MISSED APPROACH and program the FMC as required. If the airport / runway has a special engine failure on departure procedure, it should be used only in the event that a engine inoperative missed approached must be conducted.

Questions

Ensure any questions or open issues are addressed and that the flight crew is in agreement with the plan.

Shoulder Harness (Flow)ON (PM, PF)

Each flight crewmember shall keep their seat belt fastened when at their station and the aircraft is moving. Each flight crewmember shall, during takeoff and landing keep their shoulder harness fastened.



APPROACH

The Pilot Flying will call for the APPROACH Checklist as soon as practical in the approach environment.

PM Challenge	APPROACH	PM Respond
Radios & Courses	IDENTIFIED & SET (PM, PF)	
Altimeters	SET (PM, PF)	
Landing Announcement.....	CABIN READY	

PM Challenge**PM Respond**

Shoulder Harness (Flow)ON (PM, PF)

Each flight crewmember shall, during takeoff and landing keep their **shoulder harness** fastened.

Radios & CoursesIDENTIFIED & SET (PM, PF)

Prior to commencing approach, the PM will verify that all VHF radios being used for reference during the approach have been automatically tuned and the appropriate courses selected. NDBs require manual tuning. Verification of the tuned navigation station from the audio Morse code should be accomplished if the tuned frequency remains shown or an incorrect identifier is shown.

The PM will verify and/or manually insert (if required) the published RNP during RNAV/GPS approaches.

Altimeters SET (PM, PF)

Verify all altimeters are set. Verify all approach minimums are correctly set.

Nav Displays (Flow)SET

For VOR/NDB approaches, at least one pilot must select the VOR/ADF switch(es) on the EFIS control panel prior to reaching the final approach fix. Raw data for ILS, LOC and/or LOC (BC), LDA, SDF approaches is available on the PFD, for maximum situational awareness, the ND MAP mode is recommended.

The MCP and FMA should be checked to verify arming and engagement of the desired modes for the planned approach.

Landing Announcement CABIN READY

The PM will use the PRAM if available, or make the landing announcement using the following phraseology:

“FLIGHT ATTENDANTS PLEASE BE SEATED FOR ARRIVAL.”

The flight crew will verify the CABIN READY memo message has been received.

Automated LANDING announcement:

From the CABIN INTERPHONE SPEED DIAL page, select **LSK 5L**, **<LANDING FA**. This will result in the automated cabin announcement.

“FLIGHT ATTENDANTS PLEASE BE SEATED FOR ARRIVAL.”

This must be verified by observing a **PA IN USE** message in the center CDU scratch pad, or by listening to the PA audio to insure the announce was made.

APPROACH PROCEDURES**GENERAL**

The B777 is category “C” for Instrument Approaches except for Circling, which is category “D.”

Maneuvering Speeds

The flap speed schedule provides the recommended maneuvering speed for various flap settings. The schedule provides adequate buffet margin for an inadvertent 15° bank overshoot beyond the normal 25° bank. The flap speed schedule is based on additives to V_{REF} .

There are also several other benefits as a result of this schedule. It provides speeds which are close to minimum drag. In level flight it provides relatively constant pitch attitudes and requires little change in thrust at different flap settings.

FLAP SPEED SCHEDULE	
At Flap Pos	Desired Maneuver Speed
Flaps 0	$V_{REF} 30 + 80$
Flaps 1	$V_{REF} 30 + 60$
Flaps 5	$V_{REF} 30 + 40$
Flaps 15/20	$V_{REF} 30 + 20$
Flaps 25	$V_{REF} 25$
Flaps 30	$V_{REF} 30$

Caution: To prevent excessive wear or premature failure of the leading edge devices avoid flap extension near the maximum flap placard speeds. Flaps provide for operation at lower speeds and should not be used as a drag device to reduce speed. Every effort should be made to extend the flaps at as slow an airspeed as practical (as close to maneuvering speed for that flap setting as possible).

Initial pattern entry will be in a clean configuration. Slow to clean maneuvering speed prior to entering an airport traffic area. Extend the flaps to the next setting prior to decelerating below the maneuvering speed for the existing flap setting (e.g., when slowing, select flaps 1 at $V_{REF} + 80$ knots and slow to $V_{REF} + 60$ knots. Select flaps 5 before slowing below $V_{REF} + 60$ knots, etc.).

Configuration

The aircraft should normally be configured as follows, however a particular approach or specific ATC constraints may require minor modifications:

- The PF will call “FLAPS 1, SPEED” not later than:
 - downwind leg on a rectangular pattern,
 - 7 NM prior to the FAF on a straight in approach, or
 - 3 NM prior to a procedure turn outbound.
- The PF will call “FLAPS 5, SPEED” not later than:
 - beginning base leg on a rectangular pattern,
 - 5NM prior to the FAF on a straight in approach, or
 - 1 NM prior to a procedure turn point outbound.

For normal traffic patterns and approaches, the MCP selected speed bug should be progressively set to the maneuvering speed for each flap position during flap extension.

Note: If the autopilot is NOT engaged, the PF “SPEED” call after each flap extension, and “TARGET” when calling for landing flaps, are commands for the PM to progressively set the MCP selected speed bug.

When operating in an autothrottle speed mode, timely speed selections will minimize thrust lever movement during the approach, reducing cabin noise levels and increasing fuel efficiency. When flaps and landing gear are extended, be prepared to select the next lower speed just as the additional configuration drag takes effect. Delaying the speed selection will cause an increase in thrust, while selecting the lower speed too quickly will cause thrust to decrease, then increase.

Normally, the landing gear should not be extended until after flaps 20 have been selected.

The PM should be prepared, if necessary, to utilize the back up means of identifying fixes as portrayed in the profile view of the approach on the approach chart.

On all approaches, final landing configurations should be established so as to be stabilized by 1,000' above TDZ.

Stabilized Approach

The most optimum and consistent landing performance is achieved through the use of a stabilized approach. The optimum stabilized approach is defined as a flight on the glidepath (visual or electronic) at a steady rate of descent, on the “target” approach speed, in the landing configuration, in trim, and with the proper thrust setting. The dynamics of flight often dictate that flight parameters will vary from the optimum. However, experience has shown that a stabilized approach is essential for a safe operation.

Approach will be considered unstable, and shall result in a missed approach if:

1. The airspeed is greater than +15 knots or less than -5 knots from target speed, OR
2. Vertical speed is greater than 1000 ft/min, OR
3. Engines are less than minimum spooled, 45% N1.

These parameters must be met for all operations before reaching 1000 ft. above touchdown zone elevation, or a go-around will be announced by the Pilot Monitoring.

While continuing the approach (below the BOTTOM LINE altitude stated above), it must be understood that the aircraft must be correcting and trending toward the desired stable condition. Deviation from the optimum should be called out by the Pilot Monitoring.

The decision made when passing minimums or alert height is not a commitment to land. It is only a decision to continue the approach. It is possible, after passing the applicable minimums or alert height, that visual references may deteriorate, the aircraft systems may degrade, or the aircraft may deviate from the desired flightpath to a point where a safe landing may not be assured. A missed approach capability exists until selection of reverse thrust.

Altitude Callouts

Altitude callouts on all non-monitored instrument approaches are done by the PM. The callouts are in reference to the barometric altimeters as follows:

- At 1,000 feet above touchdown zone (TDZE), call out "1,000." (The PF responds, "CHECK MISSED APPROACH ALTITUDE.")
- At 500 feet above TDZE and at each 100 foot increment thereafter, call out altitude and any significant deviation from target airspeed or descent rate.
Note: A significant deviation from airspeed is ± 5 knots from Command Airspeed Bug. A significant deviation in vertical velocity is a descent rate of 1,000 fpm or greater.
- Call "APPROACHING MINIMUMS" approximately 100 feet prior to DA, DH, or DDA on instrument approaches, as applicable.
- At DA, DH, or DDA, call "MINIMUMS."
- During a CAT I (unmonitored) or Non-Precision approach, the PM will inform the PF when a portion of the approach lighting system or the runway is acquired by stating "APPROACH LIGHTS IN SIGHT" and/or "RUNWAY IN SIGHT" as appropriate.
- The GPWS system automatically annunciates 100, 50, 30, 20, 10, and therefore are not called by the PM.

Minimums

Decision Altitude (DA) or Derived Decision Altitude (DDA)

Do not continue the approach below DA or DDA, as read from the barometric altimeter, unless the airplane is in a position from which a normal descent to the runway of intended landing can be made.

The callouts APPROACH LIGHTS and RUNWAY IN SIGHT are informative only. When conducting non-precision and CAT I ILS approaches, descent below the applicable DA or DDA requires that one of the following visual references for the intended runway is distinctly visible and identifiable to the pilot:

- The approach light system, except that the pilot may not descend below 100 feet above the TDZE using the approach lights as a reference, unless the red terminating bars or the red side row bars are also distinctly visible and identifiable
- The threshold
- The threshold markings

- The threshold lights
- The runway end identifier lights
- The visual approach slope indicator
- The touchdown zone or touchdown zone markings
- The touchdown zone lights
- The runway or runway markings
- The runway lights

Decision Height (DH)

When conducting CAT II ILS approaches, descent below the DH requires that:

- The approach light system be in sight, and
- Sufficient visual references exist to maneuver the aircraft, or monitor the autoflight system, to a safe landing within the touchdown zone.

When conducting CAT III ILS approaches that incorporate a DH (LAND 2) descent below the DH requires that:

- All controlling RVRs must be reported to be at or above charted minimums.
- Sufficient visual references exist to ensure the autoflight systems will safely deliver the aircraft to the touchdown zone, and
- An AFDS annunciation of LAND 2 (autoland), and
- The designated CAT III LAND 2 DH for the B777 is 50' RA.

The decision made when passing the DH is not a commitment to land. It is only a decision to continue the approach. It is possible, after passing the DH, that visual references may deteriorate, or the aircraft may deviate from the desired flight path to a point where a safe landing may not be assured. A missed approach capability exists until selection of reverse thrust.

Alert Height (AH)

An Alert Height, as read from the radio altimeter, is a height defined for operational use above which a Category III approach would be discontinued and a missed approach initiated if a failure occurred in one of the required aircraft or ground systems. Below the Alert Height, the landing may be continued following a single failure in any of the redundant systems. Since a missed approach is required when a failure occurs prior to the AH, the lower the AH the more restrictive the approach. An AH may be used instead of a DH for CAT III approaches when the autoland status of the aircraft is LAND 3 (fail-operational). Unlike the DH concept, approaches utilizing an AH do not require the flight crew to have any external visual references to continue an approach to a landing.

When conducting CAT III LAND 3 ILS approaches, descent below the AH requires that the autoland status of the aircraft remains LAND 3.

The designated CAT III LAND 3 AH is 100' RA.

Raw Data / FMS Display

The final approach segment of all instrument approaches will be flown using the ND in the MAP mode. Applicable raw data will be monitored on the ND and PFD.

Monitored Approach Procedures

It is CAL policy that approaches will be flown auto-coupled using monitored approach procedures when the following conditions exist:

- Precision approaches with an RVR of 2,400' or less, or
- Non-precision approaches with visibility of 1 mile or less (RVR 5000 or less).

A monitored approach is a procedure that allows each crewmember to concentrate on his/her specific tasks. It utilizes the Quiet Flight Deck method that eliminates all unnecessary conversation. Any calls, other than the normal monitored approach calls, should indicate that an abnormal exists or that a performance limit was exceeded.

Using the monitored approach procedure, the First Officer is assigned the task of flying the aircraft and executing the missed approach, if necessary.

Monitored approach procedures and callouts are essentially the same for all approaches, except that some approaches incorporate minimums of either a Derived Decision Altitude (DDA), Decision Altitude (DA), or Decision Height (DH); and others reference an Alert Height (AH). It is important to realize that visual references are not required for operations utilizing an Alert Height (AH).

Note: The maximum crosswind limit for RVR values of 2,400' or less is 15 knots. If the autopilot is inoperative, the monitored approach procedures will still be used. The First Officer should fly the aircraft manually using CAT I Monitored Approach procedures. When conducting approaches to RVRs reported to be at or below 2400' (750 meters), the flight crew will brief the category of approach having the lowest minimum for which the aircraft, ILS facility, and flight crew are capable of conducting even if the latest reported weather would permit a category of approach that has a higher minimum.

Captain Duties

During a monitored approach, the First Officer is supervised or monitored by the Captain. The Captain monitors the overall approach progress and verifies the AFDS annunciation prior to 600' AGL. At 500' above the touchdown zone, the Captain calls "500," and the First Officer responds by announcing the AFDS Status Annunciator (ASA) indication ("LAND 3," "LAND 2," or "NO AUTOLAND") as appropriate. The Captain will call each 100' above touchdown zone until 100' above minimums or Alert Height. Approaching the minimums or Alert Height, the Captain will place his/her right hand underneath the First Officer's hand on the throttles.

On approaches incorporating a Derived Decision Altitude (Non-Precision), Decision Altitude (CAT I), or Decision Height, (CAT II and CAT III LAND 2), as the aircraft descends through 100' above the applicable minimums, the Captain will call "APPROACHING MINIMUMS, I'M GOING HEADS UP." At or above minimums, when the Captain sees any part of the approach light system that allows continuation of the approach below minimums, and determines a safe landing can be made, he/she will take control of the aircraft and state "I HAVE THE AIRCRAFT." With positive contact, the Captain will move the First Officer's hand up and away from the throttles. (This transfer must be made leaving no doubt in the First Officer's mind that the Captain has control of the aircraft.) Once having taken control of the aircraft the Captain will either complete the landing, or execute the missed approach if the appropriate visual cues are not in sight.

On approaches incorporating an Alert Height (CAT III LAND 3), as the aircraft descends through 200' above the touchdown zone the Captain will call "APPROACHING ALERT HEIGHT, I HAVE THE AIRCRAFT." The Captain will move the First Officer's hand from the thrust levers and assume control of the autopilot. The Captain should remain head down until the First Officer calls "ALERT HEIGHT," and must be prepared to execute a missed approach. At the EGPWS announcement "100," the First Officer calls "ALERT HEIGHT." If the criteria for a successful autoland are still satisfactory (ASA = LAND 3), no further callouts are required. If not, the captain will execute a missed approach.

First Officer Duties

A monitored approach should be flown auto-coupled with the First Officer operating the autopilot and controlling the airspeed with the use of autothrottles, if operable. The First Officer should assume the flying responsibilities early in the approach, but no later than intercept heading or, in the case of a straight in approach, 3 miles outside the outer marker.

The First Officer verifies the AFDS annunciation prior to 600' AGL. At the Captain's standard call of "500" the First Officer responds by announcing the AFDS status, ("LAND 3," "LAND 2," or "NO AUTOLAND") as appropriate.

When the Captain takes control of the aircraft, the First Officer should remain heads down, monitoring the flight progress, and making the altitude calls until 100' above TDZE. Any deviation from a stabilized flight path should be announced.

On approaches incorporating a Derived Decision Altitude (Non-Precision), Decision Altitude (CAT I), or Decision Height, (CAT II and CAT III LAND 2), if the Captain has not taken control of the aircraft upon reaching the applicable minimums the First Officer will call "MINIMUMS, GOING AROUND," and execute a missed approach.

The First Officer will also execute a missed approach any time prior to minimums if directed by the Captain.

On approaches incorporating an Alert Height (CAT III LAND 3), at 200' above the touchdown zone when the Captain states "APPROACHING ALERT HEIGHT, I HAVE THE AIRCRAFT," the First Officer relinquishes control of the aircraft to the Captain. In the event the Captain does not take control of the aircraft as stated above, upon reaching Alert Height, the First Officer calls "MINIMUMS, GOING AROUND," and executes the missed approach.

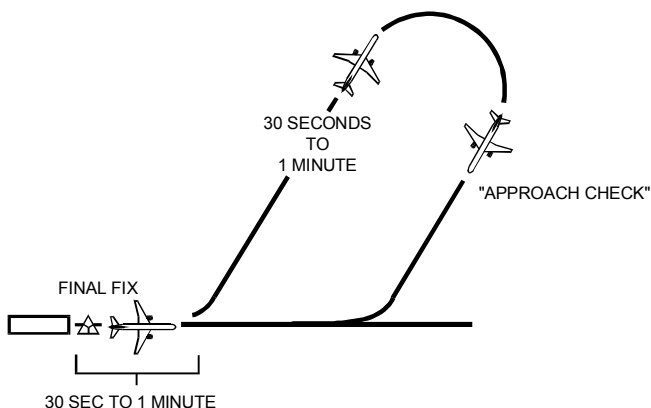
After the EGPWS automated announcement of "100'" the First Officer calls "ALERT HEIGHT" as the aircraft passes through 100' on the radio altimeter.

Procedure Turn

A procedure turn is specified wherever it is necessary to reverse direction to establish the aircraft inbound on an intermediate or final approach course. The approach plate will specify the outbound and inbound courses, the distance within which the procedure turn shall be completed, the side of the inbound course on which the turn should be made, and a minimum altitude to be maintained.

The aircraft shall fly outbound on the specified track descending as necessary to the specified altitude. If a further descent is specified after the inbound turn, this descent shall not be started until established on the inbound track ("established" is considered as being within half of the full scale deflection for the ILS and VOR, or within $\pm 5^\circ$ of the required bearing for the NDB).

Unless specified on the approach plate, the point at which the procedure turn is started is left to the discretion of the pilot. It is recommended that the turn to the outbound heading be commenced between 30 seconds and one minute past the final approach fix. Timing on the outbound procedure turn heading is also recommended at between 30 seconds and one minute. Adjust time accordingly for known winds, configuration, and/or other approach restrictions. Normally the procedure turn will be accomplished with a flaps 5 configuration and maneuvering airspeed. When established on the inbound course of the procedure turn and cleared for the approach, the APPROACH checklist should be completed.



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Note: A racetrack or teardrop pattern may be specified on the approach plate and must be flown as depicted. Times may be adjusted as required for wind.

DME Arc

A DME arc is the track of an aircraft maintained at a constant distance from a navigational aid by reference to distance measuring equipment (DME).

The distinguishing feature of the DME arc is you are required to fly your aircraft along a circular track around the navigational aid at a specified distance.

Note: The arc may be created on the ND display by selecting the FIX DME circle on the FIX INFO page. Many transitions which incorporate DME arcs are already included in the FMS data base and are selectable by choosing the appropriate approach transition.

When turning onto an arc, plan to lead your turn to avoid overshooting the desired arc. A good rule-of-thumb is to lead desired DME indication by 1% of your ground speed. For a 200 knot ground speed, lead 2 miles, and so forth.

Keeping the bearing indicator near the wing tip will keep you close to the desired arc. Flying in a series of short, straight legs is usually the best technique to use. Do not attempt to fly in a continuous bank.

The DME indication will be the same as the published DME distance each time the VOR-RDMI needle passes through the wing tip position. If you drift off the arc, make as small a correction as is practicable to return to the arc, correct 10° for each ½ mile outside the arc, and 5° for each ½ mile inside the arc. Since a graphic presentation of the station's position is important to flying a DME arc, do not attempt this maneuver with the bearing indicator inoperative.

For most DME transitions, a lead of approximately 10° will be adequate for turning from the arc to the final approach course (at 15 NM from the station, 10° of arc is equivalent to 2 ½ NM).

PRECISION APPROACHES

General

A precision approach is an approach where electronic glideslope information is available.

On approaches which incorporate minimums of a Decision Altitude (DA), or a Decision Height (DH), the aircraft is descended on the glideslope and a decision to either land or execute a missed approach must occur at or before the appropriate minimums. A decision to continue the approach below minimums requires adequate visual references as per this chapter, and the aircraft must be in a position to make a safe landing.

Note: For CAT III LAND 2 (DH) approaches all controlling RVRs must be reported to be at or above charted minimums to continue below DH to a landing.

On approaches which incorporate an Alert Height (AH), no specific visual cues are required. However, the crew must continually monitor the aircraft to assure the criteria for a successful landing are present.

Depending on weather conditions, an ILS may be accomplished with raw data, with the flight director, or with the autopilot approach coupler.

ILS approaches with visibility reported above 2400 RVR may be hand flown, or flown with the autopilot approach coupler at pilot's discretion.

Note: A flight director or approach coupler must be used when visibility below 4000 RVR or 3/4 mile.

ILS approaches in weather conditions reported or anticipated to be at or below 2400 RVR must be flown using Continental Airlines monitored approach procedures. If the crew has begun the approach using standard ILS procedures and weather conditions subsequently decrease below 2400 RVR, the aircraft may continue as briefed at Captain's discretion. Attempting to establish monitored approach procedures and configuration once the approach has commenced is not recommended.

When conducting approaches to RVRs reported to be at or below 2400 (720 meters), the flight crew will brief the category of approach having the lowest minimum for which the aircraft, ILS facility, and flight crew are capable of conducting even if the latest reported weather would permit a category of approach that has a higher minimum.

Aircraft procedures are covered on the flight profile and procedure chart. This profile may be modified to suit local traffic and ATC requirements.

Autothrottles

The autothrottle design features include automatic gust compensation. Therefore, it is not necessary to set gust or wind strength corrections on the speed selector. The system will handle the normal wind conditions encountered during the final approach and landing. However, flight crews must be alert for any unusual or extreme windshear conditions, and be ready to take manual control of the aircraft to complete the approach and landing or execute a go-around.

CAT II / III Status Annunciator Placard

The mechanical maintenance status annunciator is located on the Captain's instrument panel. The CAT II / III status annunciator is used to indicate the maintenance status of the aircraft in terms of the lowest minima authorized in conjunction with the Minimum Equipment List. The following nomenclatures will be indicated by the mechanical status annunciator:

LAND 3 - CAT II / III approaches can be conducted using LAND 3 procedures.

LAND 2 - CAT II / III approaches can be conducted using LAND 2 procedures.

CAT I ONLY - Category I only

The mechanical status annunciator is changed only at CAL maintenance stations. At non-maintenance stations, notify system control of any changes prior to dispatch.

Standard ILS Procedures

The transition to the approach may be completed using LNAV and VNAV if a complete arrival procedure to the localizer and glideslope capture POINT has been selected via the CDU. If so, the LEGS page sequence and altitude restrictions must reflect the ATC clearance. The lowest ATC clearance altitude or, when cleared for a published procedure, the lowest published altitude for that procedure will be set in the MCP ALT SELECT window.

Avoid the tendency for both pilots to be "heads-down" during the approach. Timely use of HDG SEL/TRK SEL or HDG HOLD/TRK HOLD and altitude intervention may be appropriate. In some cases, such as high-density traffic, busy ATC environment, or when an arrival procedure is desired for reference, revising the FMC flight plan may not be appropriate. In those cases, displaying the OFFPATH DESCENT circles on the map provides vertical flight path guidance that may assist in planning the approach.

If displaying the arrival procedure is not desired, perform a DIRECT TO or INTC CRS TO the final approach course on the CDU to clean up the ND.

The arrival procedure may be flown using HDG SEL / TRK SEL or LNAV for lateral tracking and VNAV, FLCH, VS, or FPA for altitude changes. VNAV is the preferred descent mode when the FMC flight plan is programmed for the intended arrival.

When VNAV is not available, use FLCH.

During the arrival, adjust the map display and range to provide an appropriately scaled plan view of the area. Select only the data from the EFIS control panel required for the arrival. This ensures the map display is not overly cluttered. When on intercept heading and cleared for the approach, select the **APP** mode and observe the **LOC** and **GS** arm annunciation's on the PFD.

Note: While maneuvering for the approach, it is company policy that ATC imposed heading, altitude, and airspeed changes be accomplished by using MCP inputs to the AFDS rather than by reprogramming the FMC. However, it is acceptable to edit the FMC for intercepting the localizer.

Localizer Capture

A 30° intercept angle is optimum. Higher intercept angles and airspeeds may cause course overshoot. APP mode should be armed prior to localizer activation to avoid undesirable overshoots. Localizer capture occurs at a variable point dependent on intercept angle, speed, and localizer deviation and rate, but never at less than ½ dot.

For normal localizer intercept angles, very little overshoot will occur. Bank angles of up to 30° may be commanded during the capture maneuver. For large intercept angles some overshoot can be expected. When localizer capture occurs, the selected heading bug automatically slews to the inbound course. At localizer capture, the FMA roll mode annunciates a green **LOC** (engaged), and pitch mode annunciates a white **GS** (armed).

G/S Capture

When the glideslope is at two dots deflection, on an ILS approach, the PF announces “FLAPS 20, SPEED.”

At 1 dot glideslope deflection the PF will call “GEAR DOWN, LANDING CHECKLIST.”

When glideslope capture occurs, the PF will call for “FLAPS 30 TARGET.” At this point, the FMA pitch mode annunciates **G/S** engaged (green). The GA mode of the AFDS arms at leading edge slat extension but is not annunciated. The A/T maintains selected speed using GA N_1 limits.

Note: The above profile will result in glideslope intercept and aircraft configured for landing with minimum power adjustments assuming the aircraft has all systems operating and no unusual ATC considerations exist. The PF may modify the profile as necessary to meet the needs of the situation. (For example, extending the gear before the flaps are at 20 to decelerate the aircraft.)

The A/P (if desired) should be engaged, the APP mode selected, and the aircraft stabilized on localizer and glidepath prior to descending below 1,000' RA.

Course Guidance

The final approach segment of a Category I, II, or III ILS begins at the point in space on the localizer course where the published glideslope intercept altitude (height) intersects the nominal glidepath (FAF). Descent on the final approach segment must never be initiated until the aircraft is within the tracking tolerance of the localizer. The ILS obstacle clearance criteria assume that the pilot does not normally deviate from the centerline more than a half scale deflection (1 dot) after being established on track. Failure to remain within this tolerance, combined with failure to remain within the glideslope tolerances, could place the aircraft outside protected obstacle clearance airspace.

During the final approach segment, the following parameters apply:

- Localizer deviation: +/- 1 dot
- Glideslope deviation: +/-1 dot
- Airspeed: -5/+10 knots of target

Exceeding any of the above listed parameters is indicative of an unstabilized approach. Deviations from the localizer and/or glideslope parameters are acceptable only for brief periods of time, and only if positive action is being taken to correct the deviation. It is recognized that ATC instructions often necessitate airspeeds higher than optimum during the initial portions of an ILS approach. When operationally desired, higher than normal airspeeds can be flown until the aircraft is in the stabilized approach regime (by 1,000' AGL). Unstabilized approaches must not be allowed to continue below 1,000' above field elevation.

Limitations and restrictions while conducting Category II and Category III approaches are, in many cases, more restrictive. Refer to the Category II/III portion of this section for specific guidance.

Decision Regime Performance Limits

The decision regime is from 500' above the TDZE to the ground. Performance limits in the decision regime are:

1. Airspeed – Plus or minus 5 knots of target speed.
2. Glideslope – Significant deviation not to exceed 1 dot high or low.
3. Localizer – Less than 1 dot deviation on the expanded scale.
4. Illumination of any warning / caution light not previously deemed acceptable for the approach - none allowed.

Note: To avoid distractions or potential confusion when the aircraft is below 500' above touchdown zone elevation (TDZE), any initial / new warning light or warning flag that comes into view in the decision regime requires a missed approach even if that warning light or flag would be acceptable under the equipment required section of CAT II/III operations. A warning light or flag that has been identified prior to the decision regime, and does not disqualify the aircraft from a CAT II/III approach, is acceptable in the DECISION REGIME.

5. Raw data must match up with computed data.
6. Rate of Descent - Maximum of 1,000 feet per minute.
7. Maximum stabilized crab angle of 10°.
8. EGPWS activation - none allowed.
9. During autoland operation, **FLARE** must be armed and annunciated.

Any violation of performance limits in the decision regime mandates an immediate go-around. Prior to the Captain taking control of the autopilot, the Captain will command and the First Officer will execute the go-around. After the Captain has taken control the First Officer will advise of deviations beyond performance limits, and the Captain will execute the go-around.

Raw Data ILS Approach

ILS course deviation is displayed on the PFD. ILS course deviation may also be displayed on the ND by selecting the Approach mode. The localizer course deviation scale on the PFD will remain normal scale during the approach and not change to expanded scale at approximately 5/8 dot, as happens with FD and/or autopilot engaged and localizer captured. The raw data displayed on the PFD may be used for the approach and the ND left in the map mode. The map display will be updated during the approach by localizer information and DME if the facility is so equipped. Continue to crosscheck the map display against the PFD raw data.

The magnetic bearing information on the ND may be used to supplement the PFD localizer deviation indication during initial course interception. Begin the turn to the inbound localizer heading at the first movement of the localizer pointer.

After course intercept, the track line and read-out on the ND may be used to assist in applying proper drift correction and maintaining desired course. Bank as necessary to keep the localizer pointer centered and the track line over the course line. This method automatically corrects for wind drift with very little reference to actual heading required.

Large bank angles will rarely be required while tracking inbound on the localizer. Use 5° to 10° of bank angle.

On precision approaches (with both engines operating), when the glideslope is at two dots, the PF should call for "FLAPS 20, SPEED." At one dot "GEAR DOWN, LANDING CHECKLIST." When intercepting the glideslope, call for "FLAPS 30, TARGET." This procedure will result in minimal trim and power adjustments. To stabilize on the final approach speed as early as possible, it is necessary to exercise precise speed control during the glide slope intercept phase of the approach. The rate of descent will vary with the glide slope angle and ground speed. Expeditious and smooth corrections should be made based on the ILS course and glide slope indications. Apply corrections at approximately the same rate and amount as the flight path deviations.

At 1000 ft. AFE the PF calls "CHECK MISSED APPROACH ALTITUDE." The PM sets the missed approach altitude and the PF verifies.

Missed Approach

To accomplish the missed approach procedure, simultaneously apply go-around thrust, call "MINIMUMS GOING AROUND, FLAPS 20" and rotate towards 15° pitch attitude. Call "CHECK POWER" and verify go-around thrust is set. At a positive rate of climb call "POSITIVE RATE, GEAR UP, CHECK MISSED APPROACH ALTITUDE" and adjust the pitch attitude to maintain bug speed. Above 400' call "HEADING SELECT" or "LNAV" as appropriate. At 1000' above field elevation, call "CHECK TOP BUG" (set the MCP selected speed bug to the maneuvering speed for the desired flap setting). Retract flaps on speed schedule. Accomplish the missed approach procedure as illustrated on the approach chart.

If a turning missed approach is required, accomplish the missed approach procedure through gear up before initiating the turn. Delay further flap retraction until a safe altitude and appropriate speed are attained.

Coupled Autopilot Approach (Autoland)

AFDS Status Annunciator (ASA)

During autopilot coupled approaches, the ASA should indicate either LAND 3 (indicating all three A/P systems, with their aircraft system inputs, are operating normally), or LAND 2 (indicating a minimum of two A/P systems, with their aircraft system inputs, are operating normally). The indications annunciate below 1500' RA with LOC and G/S captured.

NO AUTOLAND (amber) indicates a fault condition exists, precluding the use of the autopilot below 200 feet.

Below 1,500' radio altitude, the flare and rollout modes are armed, the AFDS displays LAND 3 / LAND 2. AC 120-28D requires verification of AFDS annunciation prior to descent below 600' AGL (no verbal callout is required). If an AFDS change, or system fault, occurs that requires higher weather minimums, do not continue the approach below the AH/DH (as applicable).

Note: Autolandings from ILS approaches which are not associated with active CAT II or CAT III procedures may not have the signal accuracy and/or the antennae protection required for consistently predictable results.

Runway Alignment

Runway alignment is a submode of the approach mode. With crosswinds, the crab angle is reduced at touchdown. Runway alignment also compensates for a single engine approach.

For crosswinds requiring more than 10° of crab angle, runway alignment occurs at 500' AGL. A sideslip of 5° is established to reduce the crab angle. This configuration is maintained until touchdown. The aircraft lands with the upwind wing low.

For crosswinds requiring a crab angle of between 5 and 10°, an initial alignment occurs at 500' AGL, followed by a second alignment at 200' AGL. The initial alignment initiates a sideslip to reduce the crab angle to 5°. This configuration is maintained to 200' AGL, where a second sideslip alignment increases the sideslip to further reduce the touchdown crab angle.

For crosswinds requiring a crab angle of less than 5°, no runway alignment occurs until 200' AGL, where a sideslip is introduced to align the aircraft with the runway.

If an engine fails prior to the approach, the AFDS introduces a sideslip at 1,300' AGL. This establishes a wings level configuration. If an engine fails during the approach, the wings level configuration is established when the engine failure is detected.

In the event of moderate to strong crosswinds from the side opposite the failed engine, no wing level sideslip is commanded, since the aircraft is already banked into the wind.

Autoland Callouts

To conduct an autoland the AFDS must indicate either **LAND 3** or **LAND 2**. In addition to normal precision approach calls, at 500 ft RA the PM calls "500," and the PF responds "LAND 3" or "LAND 2," as appropriate.

Flare and Rollout

At approximately 50' radio altitude, the autopilots start the flare maneuver. **FLARE** replaces the G/S pitch flight mode annunciation.

During flare:

- At approximately 25' radio altitude the autothrottle begins retarding the thrust levers to idle.
- The PFD autothrottle annunciation changes from **SPD** to **IDLE**.

At touchdown, the **FLARE** annunciation is no longer displayed, and the nose is lowered to the runway.

Between 60 and 40 feet (RA), **FLARE** changes from armed (white) to engaged (green). No calls are necessary. If the annunciation does not show engaged (green), an autoland may still be performed if the Captain feels that the aircraft is positioned for a safe landing and that safety will not be compromised.

At approximately 2 feet (RA), **ROLLOUT** engaged mode must be checked for annunciation. If not annunciated, the landing may still be concluded if the Captain feels that the aircraft is positioned for a safe landing and that safety will not be compromised.

A/P Go-Around Mode

Go-Around (TO/GA) mode is armed when the slats are extended or the glideslope is captured. Arming is not annunciated. Go-around is engaged by pushing either TO/GA switch. The mode remains engaged even if the aircraft touches down while executing the go-around.

If the flight director switches are not on, the flight director bars are automatically displayed if either TO/GA switch is pushed.

The TO/GA switches are inhibited after radio altitude decreases through two feet on landing. TO/GA is enabled again three seconds after radio altitude increases through five feet for a rejected landing or touch and go.

Caution: If TO/GA is initiated after touchdown a manual go-around must be conducted.

With the first push of either TO/GA switch:

- The PFD's display roll and pitch guidance to fly the go-around
- The autothrottle engages in thrust (THR) mode for a 2,000 FPM climb
- The AFDS increases pitch to hold the selected speed as thrust increases
- If current airspeed remains above the target speed for 5 seconds, the target airspeed is reset to current airspeed, (to a maximum of the **IAS/MACH** window speed plus 25 knots).

With the second push of either TO/GA switch:

- The autothrottle engages in the thrust reference (THR REF) mode for full go-around thrust.

TO/GA Level-Off:

- At the selected altitude, the AFDS pitch mode changes to altitude hold (ALT)
- If altitude is captured, or if FPA or VS is engaged, MCP speed is automatically set to:
 - The flap placard speed minus 5 knots
 - 250 knots if flaps are up, or
 - A speed value entered in the **IAS/MACH** window after TO/GA was pushed.
- TO/GA remains the engaged roll mode until another roll mode is selected.

TO/GA Mode Termination:

- Below 400' radio altitude, the AFDS remains in the TO/GA mode unless the autopilot is disconnected and both flight directors are turned off.
- Above 400' radio altitude, select a different MCP pitch or roll mode.
- At selected altitude, AFDS pitch mode changes to **ALT** and A/T mode changes to SPD, with thrust decreasing to maintain selected speed.
- TO/GA remains the engaged roll mode until another roll mode is selected.

CAT I, CAT II and CAT III Low Visibility Approach Procedures

All low visibility approaches to RVR at or below 2400 will be conducted using monitored approach procedures with the First Officer controlling the autopilot during the approach, and the Captain landing.

Category I approaches (RVR at or above 1800) should be autopilot coupled, but may be handflown if the autopilot is inoperative.

Category II and III approaches (RVR less than 1800) will be autopilot coupled.

Basic Operating Rules

Aircraft equipment requirements must be met. Refer to the Precision Monitored Approach Briefing Guide, this section.

No CAT II/III approaches will be made when winds (including gusts) exceed 20 knots headwind, 15 knots crosswind, or 10 knots tailwind. If LLWAS or windshear with airspeed gain or loss greater than 10 knots is reported, CAT II/III approaches will not be flown.

Approaches conducted under Category II/III procedures require an autoland. In cases of a failure that would require the aircraft to be manually flown prior to touchdown, a missed approach would normally be the only safe course of action (even if visual contact has been established with the touchdown zone).

Runway Visual Range (RVR)

CATEGORY	I	II *	III LAND 2 *	III LAND 3 *
RVR	≥ 1800	< 1800 ≥ 1000	< 1000 ≥ 600	< 600
MINIMUMS	DA ≥ 200	DH ≥ 100	DH 50	AH 100

* CAT II/III not authorized without autoland.

A CONTROLLING RVR is one that is used to determine operating minima for the approach. This concept prohibits the flight crew from beginning the final approach segment (past the glideslope intercept point or GSIP) unless the last reported RVR is at or above the minimums for the approach. All RVR transmissometers that are controlling are required.

AN ADVISORY RVR is one that does not constitute minima for the approach and provides flight crew information only. Advisory RVR transmissometers may or may not be required, depending on the approach category. (See Precision Monitored Approach Briefing Guide, this section.)

The controlling RVR concept does not prevent the flight crew from continuing the approach to minimums if a below minimum RVR report is received after the final approach fix.

Upon reaching minimums the pilot may land if flight visibility (as determined by the pilot) does not become less than the visibility prescribed in the procedure being flown, and the required visual reference is distinctly visible and identifiable.

Note: For CAT III LAND 2 all controlling RVRs must be reported to be at or above charted minimums to continue below DH to a landing.

Operations to certain international destinations have unique regulations concerning operations beyond the final approach segment (example – United Kingdom). Refer to Jeppesen “Air Traffic Control” section for specific guidance.

Note: For CAT III LAND 3 no visual reference is required.

Localizer Tracking

When performing an actual CAT II/III ILS approach and landing, flight crews should closely monitor autoflight systems and ILS raw data during the approach to ensure proper localizer tracking. The following operating practices, when conditions permit, will significantly improve localizer tracking and provide touchdown closer to runway centerline:

- The Aircraft should be stabilized on localizer and glideslope before passing outer marker, or as soon as possible after passing final approach fix.
- Monitor ILS raw data throughout the approach.

Distortion of Localizer / Glideslope Beam

If distortion or oscillation of the localizer / glideslope beam occurs, the autopilot system will attempt to follow the signal, resulting in undesirable aircraft response. Erratic ILS signals are easily detected by noting the raw data displays.

Note: There are restrictions on ground and air movements near Category II and III runways during low visibility weather conditions. These ILS Critical Areas are only protected by ATC when weather conditions are less than or equal to reported ceiling 800' and/or visibility 2 miles. Approach Control and Tower must be advised of “coupled” / “autoland” approaches on initial contact, whenever weather minimums are greater than 800/2. When in doubt of critical area protection, state your intentions. Even though critical area protection is in effect, the possibility of these areas being violated by other aircraft and/or ground vehicles is always present. This may result in guidance “beam bending” (localizer / glideslope) and the possibility of approach/runway excursion. Flight crew must diligently monitor guidance information and be prepared to immediately disconnect the autopilot during all phases of coupled operations. Attempts to overpower the autopilot in lieu of disconnect will require extreme control forces.

The Importance of Visual Cues

Use of the autopilot to minimum authorized altitude (touchdown/rollout if autoland, or 50 ft above TDZE if manual landing) is desired to prevent Duck Under and allow the maximum amount of time for acclimation to visual cues prior to autopilot disconnect.

Note: If **NO AUTOLAND** is displayed the autopilot must be disconnected by 200' above TDZE.

For CATEGORY II and III Operations, which incorporate a DH, the importance of increased visual cues prior to, and during, descent below DH cannot be overemphasized. DH is defined as a specified height above the elevation of the touchdown zone at which a decision must be made to continue the approach or to initiate a missed approach. At DH, the flight crew must be satisfied that the total pattern of visual cues provides sufficient guidance to continue the approach and landing, and that the aircraft is tracking so as to remain within the lateral confines of the runway extended and if not, they must initiate a missed approach. If the approach is continued, it is imperative that the required visual reference be continuously maintained. Flight crews should realize that visual cues can be lost after DH by encountering shallow fog, snow flurries, or heavy precipitation. Whenever visual cues are lost after DH, the flight crew should immediately initiate a missed approach.

Use of the landing lights is at the option of the Captain. Under certain atmospheric conditions, the use of landing lights will actually reduce visibility at decision height. Flight crews may find it advantageous to delay the use of landing lights until after touchdown.

Missed Approach

Upon reaching minimums / AH, if the Captain has not called out "I HAVE THE AIRCRAFT," the First Officer will execute a missed approach. The First Officer will call out "MINIMUMS, GOING AROUND".

Should a missed approach become necessary after the Captain has called "I HAVE THE AIRCRAFT," and taken control, the Captain will fly the missed approach.

Under no circumstances will a landing be attempted after a go-around has been initiated.

If unable to touchdown in touchdown zone (first 3,000'), go-around.

Precision Approach Radar (PAR) Approach

Precision Approach Radar (PAR) provides the controller with azimuth, range, and glideslope information. An approved approach lighting system enhances the approach and allows lower landing minimums. If glideslope information is not available to the controller, the PAR reverts to a Non-Precision approach system. PAR procedures must include instructions for lost communications procedures from the controller to the pilot. The final approach segment begins at the final approach fix where the radar glideslope begins (not less than 3 NM from the landing threshold) and ends at the decision height (minimum of 200 ft above TDZ) where instructions to take over visually and land, or miss the approach are received.

Pilots may expect accurate heading guidance to be furnished by the controller to keep the aircraft aligned with the extended runway centerline. The controller will provide advance notice of glideslope intercept approximately 10 to 30 seconds prior to actual intercept. The published DA will be provided only if requested. If the aircraft deviates above or below the glidepath or left or right of centerline, the pilot will receive advisory information from the controller using the phraseology “slightly” or “well” above or below or left or right of desired path. Trend information is provided by the phraseology “rapidly” or “slowly” in reference to closure to or deviation from the desired path. Range information from touchdown is provided at least once each mile while on final approach. A pilot may expect to be issued a go-around (missed approach) if the aircraft proceeds outside specified safety zone limits, unless the runway environment is in sight. After Decision Altitude (DA), advisory course and glideslope information will be issued until the aircraft passes over the runway threshold.

PAR approaches will be briefed and flown in accordance with the published PAR approach procedure. In general, the approach is flown using the MCP in HDG SEL for roll and FPA or for pitch control. The pilot will not engage LNAV or VNAV while conducting a PAR approach. Because ATC provides all azimuth, range and glideslope information, both pilots may be in the MAP mode. The approach may be built on the CDU. However, displayed **LNAV/VNAV** information is to be used for reference only and it is mandatory to comply with all controller instructions issued during the approach.

ILS PRECISION RUNWAY MONITOR (PRM) APPROACH**In Range**

- Review Jepp 11-0 PRM instructions and planned PRM approach plate.
- The following systems must be operational:
 - ILS (Cat I)
 - Transponder
 - Two VHF radios
- Advise ATC if unable to perform PRM approach.

Approach

- Set the PRM monitor frequency in #2 VHF radio. Adjust VHF 1 & 2 volume controls to ensure both pilots can hear both radios.
- Both pilots monitor both radios, transmit only on tower frequency.
- Unless contrary to Jepp 11-0 PRM instructions, TCAS should be left in TARA. If a TCAS RA and ATC Traffic Alert occur simultaneously, follow the RA climb / descent and execute the ATC turn instruction.

Actions In Event Of A Traffic Alert (Breakout)Pilot Flying

- Immediately disconnect the autopilot and manually fly the aircraft to the assigned heading and altitude (descent rates greater than 1,000 FPM are not required).
- **Do not disconnect the autothrottles.**
- **Do not push TOGA.**
- **Do not change aircraft configuration (flaps or gear) until established on the new heading.**
- Autopilot may be re-engaged after established on new heading and PM confirms MCP reprogrammed.

Pilot Monitoring

- Turn both Flight Director switches OFF.
- Set the assigned heading and altitude in the MCP.
- Turn both Flight Director switches ON.
- Push FLCH.
- Push HDG SEL.
- Advise the PF that the MCP has been reprogrammed.

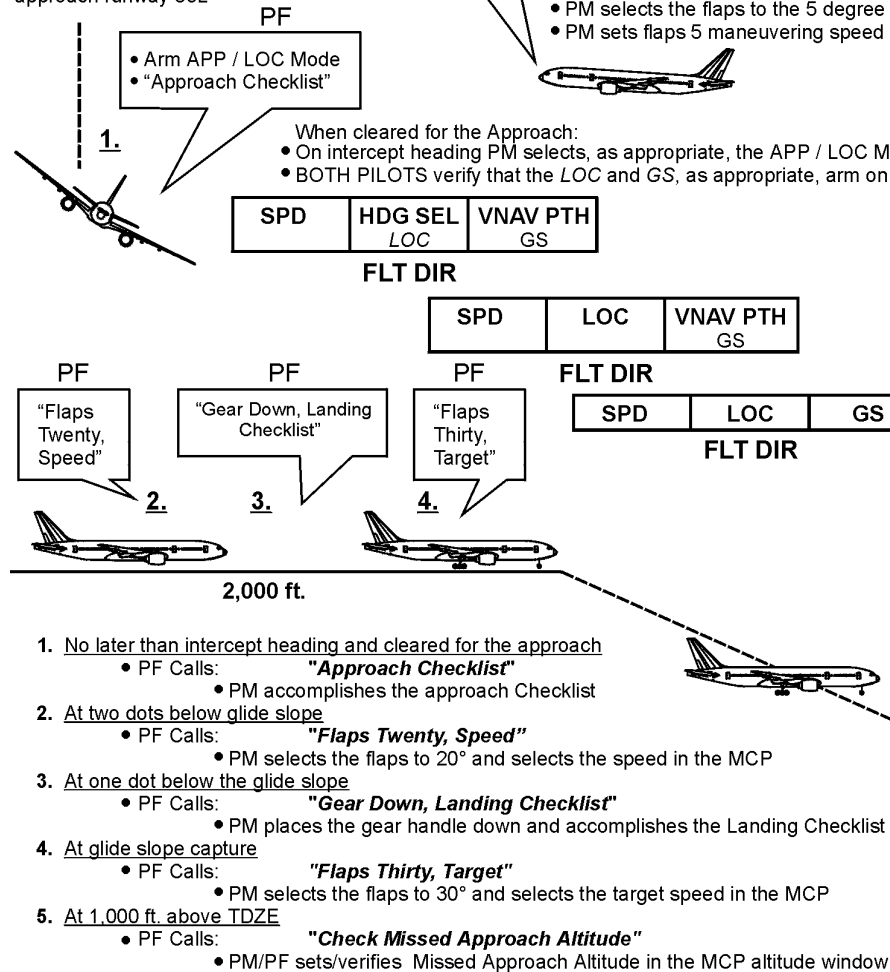
One Engine Inoperative ILS Approach

For one engine inoperative ILS approach differences, refer to Section 2.7 (Engines & APU Non-Normals) in the B777 Flight Manual under “One Engine Inoperative Approach, Landing and Missed Approach Procedures.”

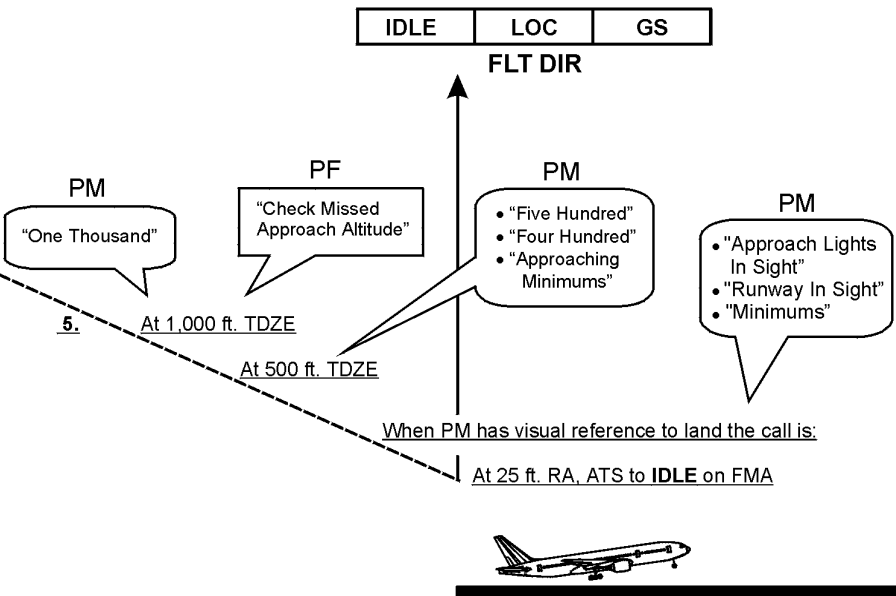
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CLEARANCE

Turn left heading 030 intercept the localizer maintain 2,000 ft. Until established cleared ILS approach runway 36L

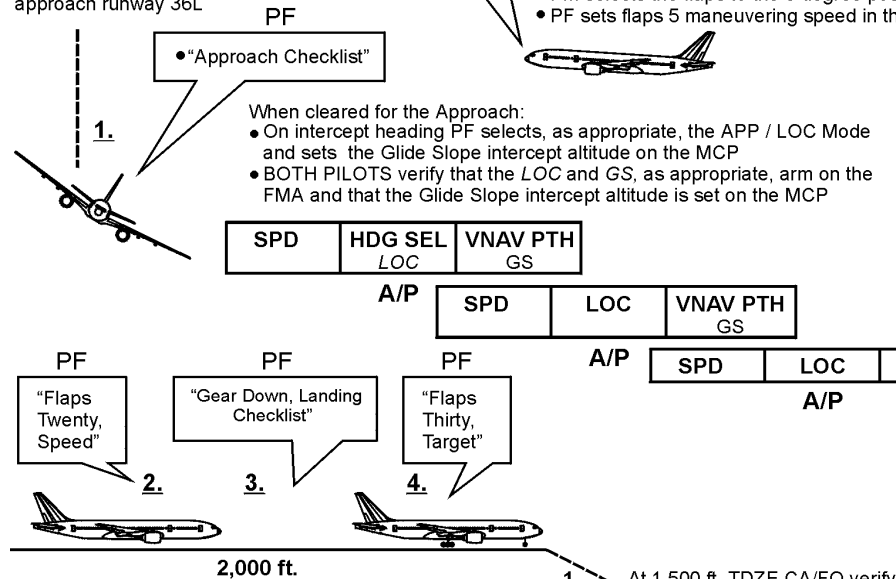


NOTES: 1. If above the GS intercept altitude when cleared for the approach, set the GS intercept altitude (for VNAV) or the next altitude restriction (for FLCH) in the MCP altitude window.
2. If using LOC mode due to altitude constraints arm the APP Mode when level at or descending through the last altitude constraint prior to the GS intercept altitude.



CLEARANCE

Turn left heading 030 intercept the localizer maintain 2,000 ft. Until established cleared ILS approach runway 36L

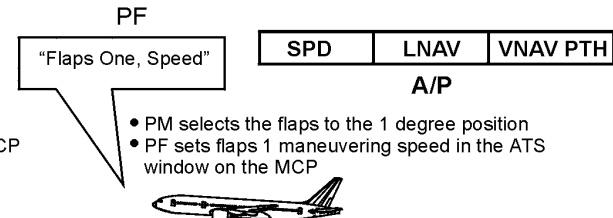


The FO should assume the flying duties early in the approach (No later than intercept HDG or, for straight in, 3 miles from OM.)

- No later than intercept heading and cleared for the approach
 - FO Calls: "Approach Checklist"
 - CA accomplishes the approach Checklist
- At two dots below glide slope
 - FO Calls: "Flaps Twenty, Speed"
 - CA selects the flaps to 20° and verifies that the speed is set in the MCP
- At one dot below the glide slope
 - FO Calls: "Gear Down, Landing Checklist"
 - CA places the gear handle down and accomplishes the Landing Checklist
- At glide slope capture
 - FO Calls: "Flaps Thirty, Target"
 - CA selects the flaps to 30° and verifies that the target speed is set in the MCP
- At 1,000 ft. above TDZE
 - FO Calls: "Check Missed Approach Altitude"
 - CA/FO sets/verifies Missed Approach Altitude in the MCP altitude window

NOTES: PF must disconnect autopilot at 200 ft. AFE if ASA shows (NO AUTOLAND).
For CAT II approach ASA must be **LAND 2 or LAND 3**.
The "Three Hundred" call is for a CAT II Approach only.
At DH the PM Calls: "Minimums".

CAT I & CAT II Monitored/Coupled Profile (VNAV)



- NOTES: 1. If above the GS intercept altitude when cleared for the approach, set the GS intercept altitude (for VNAV) or the next altitude restriction (for FLCH) in the MCP altitude window.
2. If using LOC mode due to altitude constraints arm the APP Mode when level at or descending through the last altitude constraint prior to the GS intercept altitude.

SPD LOC GS
ROLLOUT FLARE

(LAND 3 / LAND 2 / NO AUTOLAND) 1

SPD LOC FLARE
ROLLOUT

(LAND 3 / LAND 2) 2

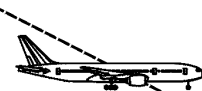
IDLE LOC FLARE
ROLLOUT

(LAND 3 / LAND 2) 3

IDLE ROLLOUT

(LAND 3 / LAND 2) 4

At 1,500 ft. TDZE CA/FO verify LAND 3/LAND 2/NO AUTOLAND on the ASA¹ FLARE and ROLLOUT arm on FMA



CA "One Thousand"

FO "Check Missed Approach Altitude"

At 1,000 ft. TDZE

At 500 ft. TDZE FO calls the appropriate ASA mode

When CA has visual reference to land the call is:

At 60 to 40 ft. RA, FO verifies FLARE on FMA

At 25 ft. RA, ATS to IDLE on FMA

At 2 ft. RA, FO verifies ROLLOUT on FMA

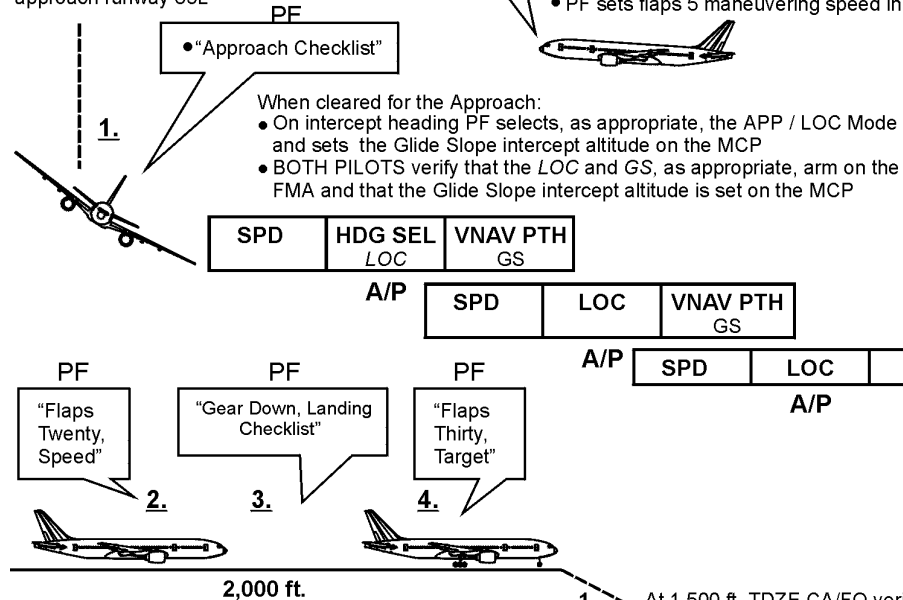


CA "Five Hundred"
"Four Hundred"
"Three Hundred"
"Approaching Minimums, I'm Going Heads Up"

CA "I Have The Aircraft"

CLEARANCE

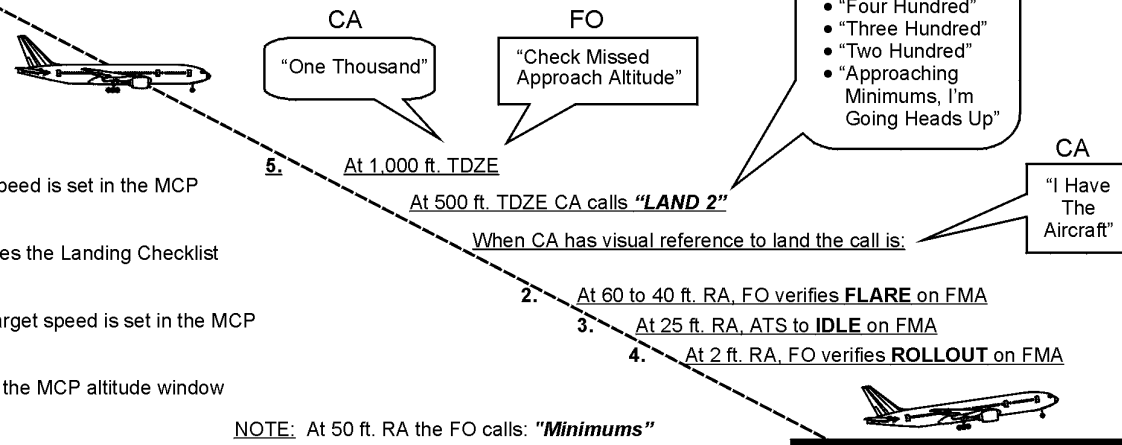
Turn left heading 030 intercept the localizer maintain 2,000 ft. Until established cleared ILS approach runway 36L



The FO should assume the flying duties early in the approach (No later than intercept HDG or, for straight in, 3 miles from OM.)

- No later than intercept heading and cleared for the approach
 - FO Calls: **"Approach Checklist"**
 - CA accomplishes the approach Checklist
- At two dots below glide slope
 - FO Calls: **"Flaps Twenty, Speed"**
 - CA selects the flaps to 20° and verifies that the speed is set in the MCP
- At one dot below the glide slope
 - FO Calls: **"Gear Down, Landing Checklist"**
 - CA places the gear handle down and accomplishes the Landing Checklist
- At glide slope capture
 - FO Calls: **"Flaps Thirty, Target"**
 - CA selects the flaps to 30° and verifies that the target speed is set in the MCP
- At 1,000 ft. above TDZE
 - FO Calls: **"Check Missed Approach Altitude"**
 - CA/FO sets/verifies Missed Approach Altitude in the MCP altitude window

At 1,500 ft. TDZE CA/FO verify **LAND 2** on ASA, *FLARE* and *ROLLOUT* arm on FMA



CAT III (LAND 2) Monitored/Coupled Profile (VNAV)

- NOTES: 1. If above the GS intercept altitude when cleared for the approach, set the GS intercept altitude (for VNAV) or the next altitude restriction (for FLCH) in the MCP altitude window.
2. If using LOC mode due to altitude constraints arm the APP Mode when level at or descending through the last altitude constraint prior to the GS intercept altitude.

SPD	LOC	GS
	ROLLOUT	FLARE

LAND 2¹

SPD	LOC	FLARE
	ROLLOUT	

LAND 2²

IDLE	LOC	FLARE
	ROLLOUT	

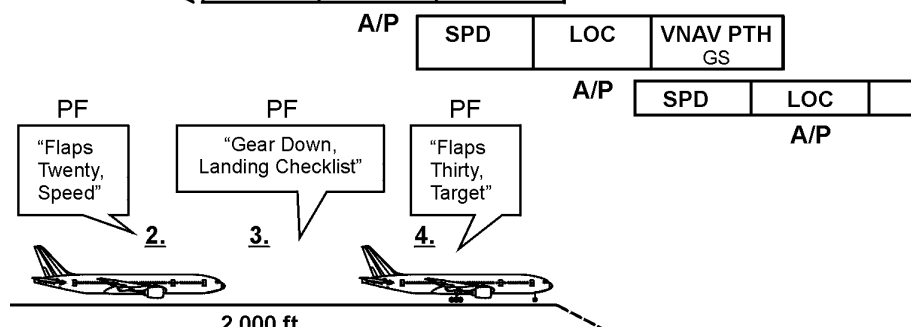
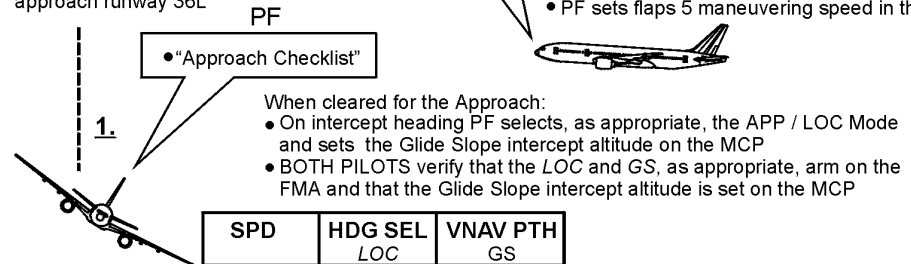
LAND 2³

IDLE	ROLLOUT	
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CA LAND 2⁴

CLEARANCE

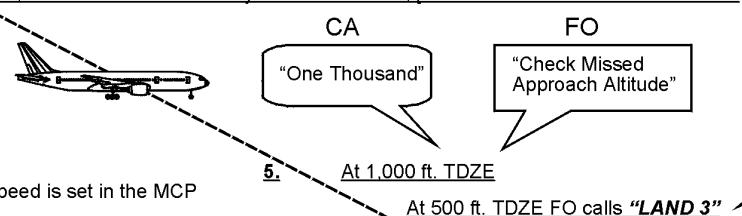
Turn left heading 030 intercept the localizer maintain 2,000 ft. Until established cleared ILS approach runway 36L



The FO should assume the flying duties early in the approach (No later than intercept HDG or, for straight in, 3 miles from OM.)

- No later than intercept heading and cleared for the approach
 - FO Calls: "Approach Checklist"
 - CA accomplishes the approach Checklist
- At two dots below glide slope
 - FO Calls: "Flaps Twenty, Speed"
 - CA selects the flaps to 20° and verifies that the speed is set in the MCP
- At one dot below the glide slope
 - FO Calls: "Gear Down, Landing Checklist"
 - CA places the gear handle down and accomplishes the Landing Checklist
- At glide slope capture
 - FO Calls: "Flaps Thirty, Target"
 - CA selects the flaps to 30° and verifies that the target speed is set in the MCP
- At 1,000 ft. above TDZE
 - FO Calls: "Check Missed Approach Altitude"
 - CA/FO sets/verifies Missed Approach Altitude in the MCP altitude window

At 1,500 ft. TDZE CA/FO verify **LAND 3** on ASA, [FLARE and ROLLOUT arm on FMA

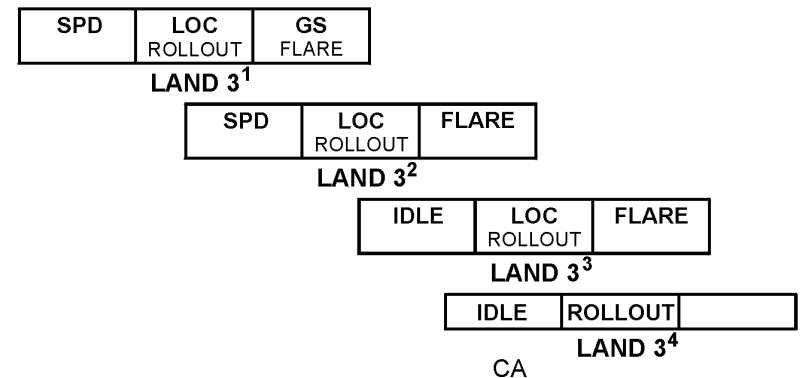


At 100 ft. RA automated call, FO calls: "Alert Height"

- At 60 to 40 ft. RA, FO verifies **FLARE** on FMA
- At 25 ft. RA, ATS to **IDLE** on FMA
- At 2 ft. RA, FO verifies **ROLLOUT** on FMA



- NOTES: 1. If above the GS intercept altitude when cleared for the approach, set the GS intercept altitude (for VNAV) or the next altitude restriction (for FLCH) in the MCP altitude window.
2. If using LOC mode due to altitude constraints arm the APP Mode when level at or descending through the last altitude constraint prior to the GS intercept altitude.



- "Five Hundred"
- "Four Hundred"
- "Three Hundred"
- "Approaching Alert Height, I Have The Aircraft"

CONTINENTAL AIRLINES B777 PRECISION MONITORED APPROACH BRIEFING GUIDE

CALL OUTS FOR MONITORED APPROACHES			
<div>CAPTAIN (PM) (MSL above TDZE)</div> <div>“1,000”→</div> <div>“500”→</div> <div>“400”</div> <div>“300”</div> <div>“200” (CAT III LAND 2 only)</div>		<div>FIRST OFFICER (PF)</div> <div>“Check Missed Approach Altitude”</div> <div>- Announce ASA: “LAND 3” or “LAND 2” or “NO AUTOLAND”</div>	
<div>(AH) ALERT HEIGHT (ASA LAND 3)</div>		<div>(DH / DA) DECISION HEIGHT / ALTITUDE (ASA LAND 3 / LAND 2 / NO AUTOLAND)</div>	
CAPTAIN	FIRST OFFICER	CAPTAIN	FIRST OFFICER
-At 100 feet <u>above</u> Alert Height, “Approaching Alert Height, I Have The Aircraft”→	-At Alert Height (After EGPWS call) “Alert Height” -If CA <u>has not</u> taken control.	-At 100 feet <u>above</u> Minimums, “Approaching Minimums, I’m Going Heads Up” - If visual acquired, “I Have The Aircraft”→	-At minimums and the CA <u>has</u> taken control of the aircraft, “Minimums” -If CA <u>has not</u> taken control.
“Minimums, Going Around”, “Flaps 20”, “Check Power”, “Positive Rate, Gear Up”, “Check Missed Approach Altitude” (at 400 ft. AGL) “LNAV” or “HDG SEL”, (at 1000 ft. AGL) “Check Top Bug”			
AFTER TOUCHDOWN During rollout, if either pilot notices the aircraft deviating from centerline, call “CENTERLINE” and the Captain will disconnect the autopilot and correct manually toward the centerline of the runway.			
MANDATORY MISSED APPROACH			
BELOW 500 FEET TO ABOVE MINIMUMS		BELOW MINIMUMS	
Change of ASA (CAT II and CAT III) Loss of required aircraft component Loss of required ground component Exceeding a performance limit		NO AUTOLAND (CAT II & III) Out of a normal landing position Loss of <u>required</u> visual references Not on the runway in the TDZ	
PERFORMANCE LIMITS (500 feet to Flare)		WIND LIMITS (Including Gusts)	
Glideslope deviation < one dot Localizer deviation < 1 dot (expanded scale) Airspeed ± 5 knots of target Maximum rate of descent is 1,000 FPM Maximum stabilized crab angle is 10° No new warning lights or flags allowed Raw data must match computed data No GPWS activation		Maximum headwind - 20 knots Maximum crosswind - 15 knots Maximum tailwind - 10 knots No LLWAS No reported windshear gain or loss greater than 10 knots	

MISSED APPROACH PROCEDURE	
<ul style="list-style-type: none">• If anything other than the briefed ASA indication is displayed after passing 1500 feet, consideration should be given to missing the approach and rebriefing the new ASA.• Prior to the “I HAVE THE AIRCRAFT” call, the First Officer will execute the missed approach procedure, if needed.• After the “I HAVE THE AIRCRAFT” call, the Captain will execute the missed approach procedure, if needed.• At minimums, if the Captain has not said “I HAVE THE AIRCRAFT,” the F/O will execute the missed approach procedure.	
NOTES: (1) If landing with flaps 30 ⁰ select flaps 20 ⁰ on the missed approach. (2) If landing with flaps 20 ⁰ select flaps 5 ⁰ on the missed approach.	
CAUTIONS: (1) The TO/GA switches are inhibited below 2 ft. radio altitude until 3 seconds after radio altitude increases through 5 feet. (2) UNDER NO CIRCUMSTANCES WILL A LANDING BE ATTEMPTED AFTER A GO-AROUND IS INITIATED.	
LANDING PROCEDURES	
<ul style="list-style-type: none">• Proper seat height is necessary to ensure optimum cut-off angle for a visual landing.• Approaching minimums, the Captain should place his/her hand on the throttle quadrant in anticipation of the “I HAVE THE AIRCRAFT” call and assuming control of the aircraft.• It may be advantageous to delay using the landing lights until after touchdown, or not at all.• Use of the autopilot to minimum altitude is advised: LAND 2 / LAND 3 – Disconnect autopilot after landing and rollout. NO AUTOLAND – Disconnect autopilot at 200 feet.• Autobrake setting must be a minimum of 3 for CAT III landings to ensure compliance with runway requirements.• RVR < 1200 requires reported braking action of fair or better.	
TO CONTINUE BELOW MINIMUMS, THE PILOT MUST ACQUIRE THE FOLLOWING:	
CAT I (DA)	– Sufficient “visual reference to the intended runway.”
CAT II (DH)	– Sufficient “visual reference with the CAT II lighting system” to safely continue the approach on visual reference alone. (Autoland required)
CAT III (DH)	– Sufficient “visual reference with the touchdown zone or TDZ lights” to verify landing in the touchdown zone and LAND 2 displayed. Crew may not continue below DH unless RVR is reported at or above charted minimums.
CAT III (AH)	– No visual references required and LAND 3 displayed.
WARNING:	ROLLOUT MODE WILL DISENGAGE WITH HEAVY RUDDER PEDAL FORCES.

Note: Double outline area signifies minimum crew brief.

CREW QUALIFICATION													AIRCRAFT (After Dispatch Reference)												
If the Captain has less than 100 hours in type, the following crew restrictions apply: 1. CAT III Not Authorized 2. CAT II Authorized (Autoland required) 3. CAT I Authorized (Autopilot required) (Autoland required if operational)													AFDS Status Annunciator (ASA) indicates aircraft capability, <u>unless</u> further restricted by MEL, Maintenance CAT II / III Status Placard, Dispatch Release or Approach Chart.												
AIRPORT REQUIREMENTS														CATEGORY I	CATEGORY II	CATEGORY III									
<ul style="list-style-type: none">Published chart for category of approachGlideslope angle: Minimum 2.5⁰ and Maximum 3.25⁰All required approach navigation aids in service (ATC and NOTAMS will advise if not)ALSF-1 or 2, or ICAO equivalent Note: (SFL not required for CAT III)High Intensity Runway Lights (HIRL), TDZ Lighting and Centerline Lights (CL)Full runway length (or dispatch approved reduced length) Note: For RVR < 600 (175m), SMGCS or ICAO equivalent low vis taxi plan is required. When the approach chart is issued with < 600 (175m) minimums, the airport has an approved plan.															AUTOLAND REQUIRED										
													REQUIRED EQUIPMENT	Coupled / Manual ≥ 1800 RVR (550m)	Coupled < 1800 but (550m) ≥ 1000 RVR (350m)	LAND 2 ≥ 600 RVR (175m) DH = 50 ft	LAND 3 < 600 RVR ❶ (175m) AH = 100 ft								
													Autopilot (A/P)	1 ❷	2	2	3								
													FD Display	1 ❷	2	2	2								
													PFD	1	2	2	2								
													ILS	1	2	2	3								
AIRCRAFT / APPROACH CAPABILITIES													Radio Altimeter	0	2	2	3								
EICAS (>1500 ft.)	A/C Capability (ASA <1500 ft.)	Approach Capability	Minimums: CAT I / II CAT III										AFDS FMA	1	1	1	2								
BLANK	LAND 3	CAT I / II / (III < 600)	Charted	(AH = 100ft RA)									AFDS ASA	1	1	1	2								
NO LAND 3	LAND 2	CAT I / II / (III ≥ 600)	Charted	(DH = 50ft RA)									AP Disengage Switch	0 ❸	2	2	2								
NO AUTOLAND	NO AUTOLAND	CAT I Only	Charted	(CAT II & III N/A)									AP Disc Warning	YES	YES	YES	YES								
MINIMUM / VISIBILITY REQUIREMENTS													Autothrottles	0	0	0	1 ❹								
(Prior to final approach)													A / T Disc. SW	0	0	0	1								
Monitored Approach required with RVR ≤ 2400ft (750m)													Rollout System	NO	NO	NO	YES								
CAT I		CAT II		CAT III										Thrust Reverse	NO	NO	NO	If < 600' RVR ❺							
		(Autoland Req CAT II & III)		LAND 2		LAND 3										Anti-Skid	NO	NO	NO	If < 600' RVR ❺					
MINIMUMS													Autobrakes	NO	NO	NO	If < 600' RVR ❺								
DA = Charted (Baro)		DH = Charted (RA)		DH = 50 ft (RA)		AH = 100 ft (RA)										Ground Speed Ind	NO	NO	NO	If < 600' RVR ❺					
RVRs													Windshield Wipers	NO	Req. when falling precipitation within 5 miles of landing field										
													Engines	1	1	1	1								
TDZ	Controlling Required If inop; MID may be used and becomes controlling and required.	Controlling 1600 (500m) Required (without MID <u>and</u> RLO) 1000 (300m) Required (with RLO or MID)		Controlling Required 600 (175m)		Controlling 600 (175) or, 300 (75m) when published. If inop, MID and RLO Controlling.		NOTES: <ul style="list-style-type: none">❶ 300 RVR (75m) when authorized on approach plate.❷ At least one Autopilot or Flight Director must be operational and used.❸ If autopilot engaged below 1500' AGL, both AP Disengage switches must operate.❹ At least one autothrottle servo must be operational and used for <u>all</u> CAT III LAND 3 approaches.❺ If all are inoperative, increase the additional field length requirement by 1.3.																	
MID	Advisory Not Required , Unless TDZ inop.	Advisory Not Required , Unless RLO inop.		Controlling Required 400 (125m)		Controlling 300 (75m) If inop, TDZ and RLO Controlling.																			
RLO	Advisory Not Required	Advisory Required if TDZ is <1600 (500m). If inop, MID may be used.		Advisory Required or Controlling Required 400 (125m) (if mid < 600)		300 (75m) Advisory (if TDZ & MID ≥ 600) Controlling (if TDZ or MID < 600) If inop, TDZ & MID Controlling.																			
FEET	150	300	400	500	600	700	1000	1200	1600	1800	2000	2400													
METERS	50	75	125	150	175	200	300	350	500	550	600	750													

NON-PRECISION APPROACHES

General

A non-precision approach is any kind of instrument approach where electronic glideslope information is not provided by the primary ground based navigational aid.

FAA regulations allow new generation aircraft to take advantage of the onboard equipment capability to fly non-precision approaches utilizing a constant rate of descent to follow the aircraft generated glide path to a decision altitude (DA) verses a minimum descent altitude (MDA). In some cases this affords lower minimums when using this VNAV capability. If a DA is not published for a particular approach, the B777 policy is to add 50 feet to the published MDA, and use this altitude as a Derived Decision Altitude (DDA). The B777 aircraft demonstrated altitude loss during automatic go-around is never more than 27 feet, therefore this will ensure that the aircraft does not descend below the published MDA if a missed approach is initiated at the DDA. If a DA is published, it is acceptable for the aircraft to descend below the DA during the execution of the missed approach (as is the case when using a ground based electronic glideslope).

Note: If the approach plate has a ball note in the profile section of the chart stating, "Only authorized operations may use VNAV DA in lieu of MDA," the use of the DDA is not required. An obstacle assessment has been completed for the visual segment of the approach allowing a descent below MDA on a missed approach. Continental Airlines is an authorized operator, and all Continental Boeing crews can use the charted MDA as a DA when using VNAV vertical guidance.

The FMC is capable of computing a very accurate vertical path to the runway when the proper information is entered. This will provide a much more accurate and stabilized method of descending the aircraft. The aircraft is descended along this artificial path until the DA/DDA is reached. The path is normally followed by using VNAV with speed intervention, but can be flown using FPA or V/S until the DA/DDA is reached. This technique allows the aircraft to be flown at a stabilized descent rate to the DA/DDA at which point a normal landing can be completed or a missed approach accomplished if adequate visual references are not present. The DA/DDA coincides with the visual descent point (VDP). This is a significantly different philosophy than the old concept of descent to MDA and level flight to the VDP or MAP.

The following policies will apply to the execution of these approaches:

- All non-precision approaches will be flown using the autopilot (and autothrottles if available).
- The preferred method to fly the path from the Final Approach Fix is VNAV with speed intervention. (If VNAV is not available or desired, then FPA or V/S, in that order of preference).
- All constant rate of descent non-precision approaches in weather conditions reported or anticipated to be below 5000 RVR or below 1 statute mile, will be flown using Continental Airlines monitored approach procedures.
- If a vertical path is not present (i.e., if a VNAV Path Deviation Scale (VPDS) is absent at the FAF inbound), the approach should normally be missed and the discrepancy resolved prior to initiation of another approach. If the path is not present on the subsequent approach, such as during an equipment malfunction, an appropriate constant rate descent to the DA/DDA may be utilized. A descent rate of approximately 3° FPA or a V/S not to exceed 1500 fpm rate of descent from the FAF inbound should be used in this situation of a vertical path not being present. V/S shall not exceed 1000 fpm at and below 1000' above TDZE. Some charts provide guidance for descent rates appropriate for a particular approach with different ground speeds. Some approaches will require simple calculations of required vertical speed to arrive at the DA/DDA coincidentally with the VDP when the vertical path is not present.
- The primary underlying navigation aid (VOR, NDB, LOC, etc.) must be operational in order to execute an approach that is titled solely by that specific navaid (i.e., NDB Rwy 26 or VOR Rwy 13). However, if the approach has multiple options listed in the procedure identification, and the alternate NAV source will provide suitable guidance, then the ground based navaid may be inoperative (i.e., NDB or GPS Rwy 24R or VOR or GPS Rwy 07L/R). Also, if the instrument approach procedure is retrievable from the airborne database, then GPS alone may be used to fly the approach.

LNAV / VNAV Approach

FMC Set Up

In order to use LNAV and VNAV, a proper series of legs/waypoints which denote the approach and missed approach procedure must be present on the LEGS page. It is important to program the target speed and altitude for the FAF in order for the FMC to correctly calculate and manage deceleration points.

This will insure the aircraft does not have excessive energy (speed or altitude) at the FAF. Although there are several methods of programming the FMC, the following are the most common:

- Data Base Selection

An approach procedure selected through the CDU DEP/ARR page provides the simplest method of selecting proper waypoints. Procedures in the data base comply with obstruction clearance criteria for non-precision approaches.

Caution: Data base selection is the only authorized method of loading waypoints for an RNAV/GPS approach procedure.

Note: An approach stored in the data base as a non-precision approach will meet all step-down fix requirements and while a cross check of raw data for the crossing fix is appropriate, it is not necessary to insert such fixes into the LEGS page.

- Approach Overlay

If the approach to be flown is not listed, select an approach with the same or similar plan view to use as an overlay (ILS for NDB or ILS G/S inoperative) if available. Insert target speed at the final approach fix. Verify the altitude of the Final Approach Fix; it may need to be changed from the Glide Slope Crossing Altitude. These altitude entries allow the FMC to construct a vertical path to the runway. Finally, check that the missed approach procedure agrees with the charted procedure.

- Manual Waypoint Entry

When there is no procedure available in the FMC data base, manual entry of a series of waypoints may be accomplished to define the approach routing. The waypoints may be defined by using names of waypoints or navaids in the data base.

Manual entry increases the workload and should normally be completed prior to top of descent. Because procedure turns and DME arcs cannot be manually entered (unless they can be defined by a series of waypoints), such turns may require use of the MCP TRK SEL or HDG SEL mode. Such deviation from the defined route may require use of direct to or INTC CRS TO when intercepting the Final Approach Course.

Displays

The use of the MAP mode is encouraged. The map display provides a plan view of the approach, including final approach and missed approach routing and increases crew awareness of progress and position during the approach. Raw data information from VOR, NDB, and LOC facilities must be monitored on the PFD/ND displays as appropriate. Additionally, consideration should be given to the use of the TERR pos on the EFIS control panel when near significant terrain. Providing both GPS receivers are functional and are updating the FMC position, neither pilot is required to have his EFIS control in APP or VOR mode during descent or approach provided the raw data is monitored on PFD/ND.

Caution: If a disagreement between LNAV and the raw data information exists, use of LNAV must be terminated and raw data information followed using TRK SEL or HDG SEL.

Pilots must not allow themselves to become involved in excessive heads down FMC manipulation at low altitude. Raw data VOR, ILS and ADF displays should be used in the traditional manner to avoid such distractions during high workload phases of flight.

The map is useful when the inbound course is not aligned with the runway centerline. The map will graphically display the difference between the extended runway centerline and the published inbound course, allowing the pilot to clearly determine the alignment maneuver required.

Note: For all non-precision approaches, timing is required only if the published MAP point is time based and cannot be defined and displayed on the ND map. This is for purposes of determining the geographical point at which a turn or other constraint can be made during the missed approach and not for the determination of when to begin the missed approach procedure. The vertical portion of the missed approach will be accomplished immediately upon arrival at the DA/DDA if the required visual references for landing are not present, regardless of the time from the FAF or time remaining to the MAP.

Recommendations for each type of non-precision approach are:

- RNAV/GPS: Flown using the MAP mode only. Use of LNAV is required for the approach (and missed approach if appropriate). The preferred method to fly the path from the Final Approach Fix is VNAV with speed intervention. (If VNAV is not available then FPA, or V/S, in that order of preference.) There is no raw data back-up requirement. The crew must insure the correct Required Navigation Performance (RNP) value appears on FMC POS 2/3 if it is defined on the approach plate. This may necessitate changing the defaulted RNP value (normally set at 0.50 NM in the terminal area). Additionally, the crew must insure that the **NAV UNABLE RNP** EICAS message does not appear after the FAF inbound and the aircraft symbol must touch the active course line using the 10 mile scale, otherwise a missed approach must be executed and the discrepancy resolved.
- LOC, LDA, and SDF: Use the MAP mode. Localizer is tracked using LOC. When on an intercept heading select the LOC mode and observe the LOC arm annunciation on the PFD. At localizer capture the FMA roll mode annunciates green **LOC** (engaged) mode. Raw data course information and localizer DME are displayed on both pilots PFD's. The preferred method to fly the path from the Final Approach Fix is VNAV with speed intervention. (If VNAV is not available then FPA, or V/S, in that order of preference.)
- BC Localizer: Use the MAP mode. BC Localizer is tracked using LNAV. Raw data course information and localizer DME are displayed on both pilots PFD's. The preferred method to fly the path from the Final Approach Fix is VNAV with speed intervention. (If VNAV is not available then FPA, or V/S, in that order of preference.)

Note: There is no back course selection on the MCP, and the **LOC BC** signal cannot be tracked by the autopilot or flight director. The front course is automatically selected on the NAV RAD page if the BC approach is listed on the DEP/ARR page.

- VOR: Use the MAP mode. LNAV should be used for tracking as long as no disagreement with raw data is noted. Select the VOR position of the VOR/ADF switches on the EFIS CONTROL PANEL to display raw data information on the needles. Cross check any stepdown restrictions with the raw data DME; however, it is not necessary to enter these fixes since a stored approach will honor all crossing restrictions. A missed approach will be executed upon arrival at the DA/DDA regardless of the geographical location of the published missed approach point, if the required visual cues for landing are not present. The preferred method to fly the path from the Final Approach Fix is VNAV with speed intervention. (If VNAV is not available then FPA, or V/S, in that order of preference.)

Note: Normally, do not manually tune VOR frequencies or courses when the approach is loaded from the FMC data base. They will be automatically tuned for the procedure, and manual selection may tend to clutter the display with the green course line.

There are some VOR approaches where the VOR itself is the missed approach point (there is not a separate missed approach waypoint “MAXXX”), and it is located near or beyond the runway threshold, such as BOS VOR DME 33L. Hence, the path created from the FAF to the VOR does not represent the desired vertical path to the runway. For these particular approaches, use a FPA of 3 degrees or V/S of approximately 800 fpm consistent with approach geometry and ground speed. Disregard the VPDS indications as they will be incorrect, in fact, reflecting the path from the FAF to the VOR and it’s associated crossing altitude. If followed, this path will normally place the aircraft above the desired vertical path. These approaches can be identified by reviewing the altitudes that are stored in the procedure and recognizing that they do not define a usable vertical path.

- NDB: Use the MAP mode. LNAV should be used for tracking as long as no disagreement with raw data is noted. Enter NDB frequency on NAV RAD page of the FMC. Select the ADF position of the VOR/ADF switches on the EFIS control panel to display raw data information. The preferred method to fly the path from the Final Approach Fix is VNAV with speed intervention. (If VNAV is not available then FPA, or V/S, in that order of preference.)

- ASR: Use the MAP mode. HDG SEL should be used for tracking. ATC provides all azimuth directions (and recommended altitudes on final, if requested). Use FPA or V/S for the descent. Consider using the VFR APPR selection from the ARRIVALS page if available for the particular runway. The RWY EXT function from the ARRIVALS page may also be used. A 3° VNAV path to the runway may be constructed by defining a fix on the extended runway center line and inserting an appropriate altitude at the fix (approximately 330' per NM) and 50' over the runway, i.e., a 6 NM fix times 330' = 1980' + TDZE crossing over the 6 NM fix.

Approach Procedures

The aircraft should normally be configured as follows, however a particular approach or specific ATC constraints may require minor modifications:

- The PF will call "FLAPS 1, SPEED" not later than: downwind leg on a rectangular pattern; 7 NM prior to the FAF on a straight in approach; or 3 NM prior to a procedure turn outbound.
- The PF will call "FLAPS 5, SPEED" not later than: beginning base leg on a rectangular pattern; 5NM prior to the FAF on a straight in approach; or 1 NM prior to a procedure turn point outbound.

Engaging VNAV with speed intervention early is encouraged and will assist in smoother flying and better monitoring of the approach. VNAV with speed intervention should be engaged no later than 3 miles from the FAF. Plan the approach so as to be stabilized prior to crossing the FAF in landing configuration with speed stabilized at target.

Final Approach

Set zero in the MCP altitude window only after VNAV with speed intervention is engaged and after being cleared for the approach (prior to the FAF). Confirm MCP altitude is set to zero, the FMA indicates VNAV PTH, and the FMC LEGS page altitude is magenta. The FMA will continue to indicate VNAV PTH during descent to DA/DDA. If using FPA or V/S, the FMA will indicate ALT approaching the FAF and either FPA or V/S (depending on crew selection) during the descent to DA/DDA.

- At 3 miles prior to the FAF, the PF will call “FLAPS 20, SPEED.”
- At 2 miles prior to the FAF, the PF will call “GEAR DOWN, LANDING CHECKLIST.”
- At 1 mile prior to the FAF, the PF will call “FLAPS 30, TARGET.” The PM will complete the landing checklist.

The VNAV Path Deviation Scale (VPDS) indicates the vertical path. If VNAV is not engaged, follow the VPDS using either FPA of approximately 3° or V/S of approximately 700 - 800 fpm. Descent from the FAF inbound to the runway when using FPA or V/S should be with reference to the VPDS. Maintaining the VNAV path as indicated by a centered VPDS is desired. Deviations below a centered VPDS are only acceptable if positive correction back to the VNAV path is being made. Corrections for a late initiation of descent (VPDS shows the aircraft is high relative to the computed VNAV path) will be made within the following constraints:

Descent below 1000 ft. above TDZE shall not exceed 1000 fpm, regardless of pitch mode utilized. The planned pitch mode must be included as part of the Approach Briefing. A backup pitch mode should be briefed to follow the VPDS if the planned mode is not attained

Note: Certain non-precision approaches contain guidance to provide a constant rate of descent from the initial approach altitude to the published MDA. This will be indicated on the approach chart by a steady descending profile line and/or descent gradient charts with minimum published altitudes and/or descent rates. In these cases, the flight path must be controlled to remain at or above the published profile altitudes. Using VNAV PTH or following the VPDS will fulfill this requirement.

Note: Certain data base stored non-precision approaches will not cause a VNAV PTH descent until as much as 50 (fifty) seconds after passing the FAF. This is because FAF altitude and distance from the runway threshold would cause a very shallow immediate descent. Normally, the FMC will not begin the descent on these types of approaches until an approximate 3° path is achieved. This delayed path descent feature should be anticipated by a review of the approach chart vertical geometry and emphasized during the approach briefing.

As the aircraft descends through 1000 ft. above the TDZE, the PM calls “1000” and the PF calls “CHECK MISSED APPROACH ALTITUDE.” Normally, the PM sets MAP altitude in the MCP. Initially set the lowest altitude listed as a restriction in the missed approach procedure and then subsequent altitudes when appropriate. TOGA pitch mode will not honor intermediate restrictions if the final altitude is set. At 100’ above the DA/DDA the PM calls “APPROACHING MINIMUMS” (and if executing a monitored approach, also “I’M GOING HEADS UP”). The PM should attempt to visually acquire the runway environment. The PF should continue to direct attention to the instruments to ensure aircraft control until advised by the PM “APPROACH LIGHTS (and/or RUNWAY) IN SIGHT.” If executing a monitored approach, the Captain will call “I HAVE THE AIRCRAFT” when adequate visual references are established and take control of the aircraft. When the PF leaves the DA/DDA, the PM will resume the monitoring and standard calls.

The autopilot must be disengaged not lower than 50’ below published DA or 100’ below DDA (this fulfills the necessity to disconnect by 50’ below the published approach MDA). Using VNAV PTH to this point ensures the aircraft is stabilized and on an approximate 3° path to the runway. The same result should occur if using FPA or V/S and following the VPDS.

Course Guidance

The final segment of the non-precision approach begins at the Final Approach Fix (FAF) and ends at the Missed Approach Point (MAP). On non-precision approaches with no depicted FAF (such as on airport radio facilities), the FAF is considered to be located at the point where the aircraft is established inbound on the final approach course from the procedure turn, and where the final approach descent to MDA may be commenced.

During the final approach segment of a non-precision approach prior to reaching DA/DDA, the following restrictions apply:

- Localizer deviation: 1 dot
- VOR course deviation: 1 dot or + / -5 deg.
- NDB: + / -5 deg.
- Airspeed: -5 / +10 knots of target speed
- Cross Track Error: (RNAV/GPS only) Aircraft symbol must touch the active course line using the 10 mile scale.
- Maximum rate of descent below 1000 ft. above TDZE: 1000 fpm
- Deviations from the VNAV computed path (VPDS) should not exceed 1/4 scale high or 1/8 scale low.

Other than a brief deviation, any exceedance greater than the above listed parameters is indicative of an unstabilized approach and requires the execution of a missed approach. It is recognized that ATC instructions often necessitate airspeeds higher than optimum during the initial portions of an instrument approach. However, unstabilized approaches must not be continued below 1000' above TDZE.

Transition To Landing

Descent below DA/DDA requires visual conditions. Accomplish a missed approach if the required visual conditions do not exist for landing, or if the aircraft is not in a position to continue a stabilized descent to landing. The parameters associated with stabilized approaches apply. After the decision has been made to land, it is not appropriate to turn the flight directors off or attempt to change pitch/roll modes. This phase of the approach from DA/DDA to landing is a visual maneuver, and attempting to make the flight directors reflect correct guidance commands below DA/DDA by changing modes is not appropriate.

Note: Descent path created by the FMC may not coincide with VASI/PAPI. When VASI/PAPI is available, use it to continue descent to the runway.

Missed Approach

Upon reaching the DA/DDA, (regardless of the pitch mode utilized to descend the aircraft), if the PM has not acquired the approach lights or the runway environment, he/she will call "MINIMUMS." The PF selects TO/GA, calls "MINIMUMS, GOING AROUND," and executes the missed approach.

Note: If the autopilot is engaged, it should remain engaged. If the autopilot has been disconnected after reaching the DA/DDA, rotate smoothly towards 15 deg. pitch attitude and then follow flight director commands.

TO/GA initially commands a go-around attitude and then transitions to speed as the rate of climb increases. This speed is the existing airspeed or selected MCP command airspeed, whichever is higher. TO/GA maintains existing ground track. Passing 400' AFE, select LNAV or HDG SEL/TRK SEL as appropriate. On approaches with DA/DDA's above 400' AFE, select LNAV or HDG SEL/TRK SEL as appropriate after the "CHECK MISSED APPROACH ALTITUDE" call.

Accomplish the missed approach procedure. If a turning missed approach is required, accomplish the missed approach procedure through gear up before initiating the turn, unless there is a special procedure required by the approach or Jepp 10-7 page. In the event of executing a missed approach prior to the published missed approach point, initiate a climb toward the missed approach altitude; however, do not begin a turn until reaching the published missed approach point. For missed approaches that are not stored in the NAV data base (such as a different missed approach procedure for the NDB as opposed to the associated ILS) HDG SEL/TRK SEL may be required to comply with the procedure.

The MCP selected airspeed bug should remain at the final approach speed until 1000' AFE (or special MAP altitudes). Accelerate to flap retraction speed by calling "CHECK TOP BUG" (or speed for the desired flap setting). Retract the flaps on schedule as the airspeed increases.

Circling Approaches

All Continental aircraft are considered Category D aircraft for purposes of circling approaches.

Continental Airlines Operations Specifications requires any circling approach to be conducted in weather conditions of at least 1000' ceilings and 3 miles visibility. Therefore, if a circling approach is conducted it must be in weather conditions equal to or greater than 1000'/3 or Category D charted circling landing minimums, whichever is higher.

Maintain a configuration of flaps 20, gear down at a speed of $V_{REF}30 + 20$ while maneuvering at 1000 feet above field elevation or Category D circling MDA, whichever is higher. This altitude must be maintained until in position to make a normal descent to the runway. At that time, select landing flaps and reduce speed to target. Complete the LANDING checklist.

A missed approach must be made whenever an identifiable part of the airport is not distinctly visible once reaching minimums. To become established on the prescribed missed approach course, the pilot should make an initial climbing turn toward the landing runway and continue the turn until the aircraft is established on the missed approach course or as directed by the control tower.

The PM should provide maneuvering instructions and/or monitoring of altitude and airspeed as directed by the PF. Care should be taken to avoid a situation where both pilots' attention is directed out of the flight deck. When the PF begins the visual descent to the runway, the PM should closely monitor airspeed and rate of descent.

Due to the VFR weather minimums of 1000'/3 restriction, circling approaches are not specifically trained or checked.

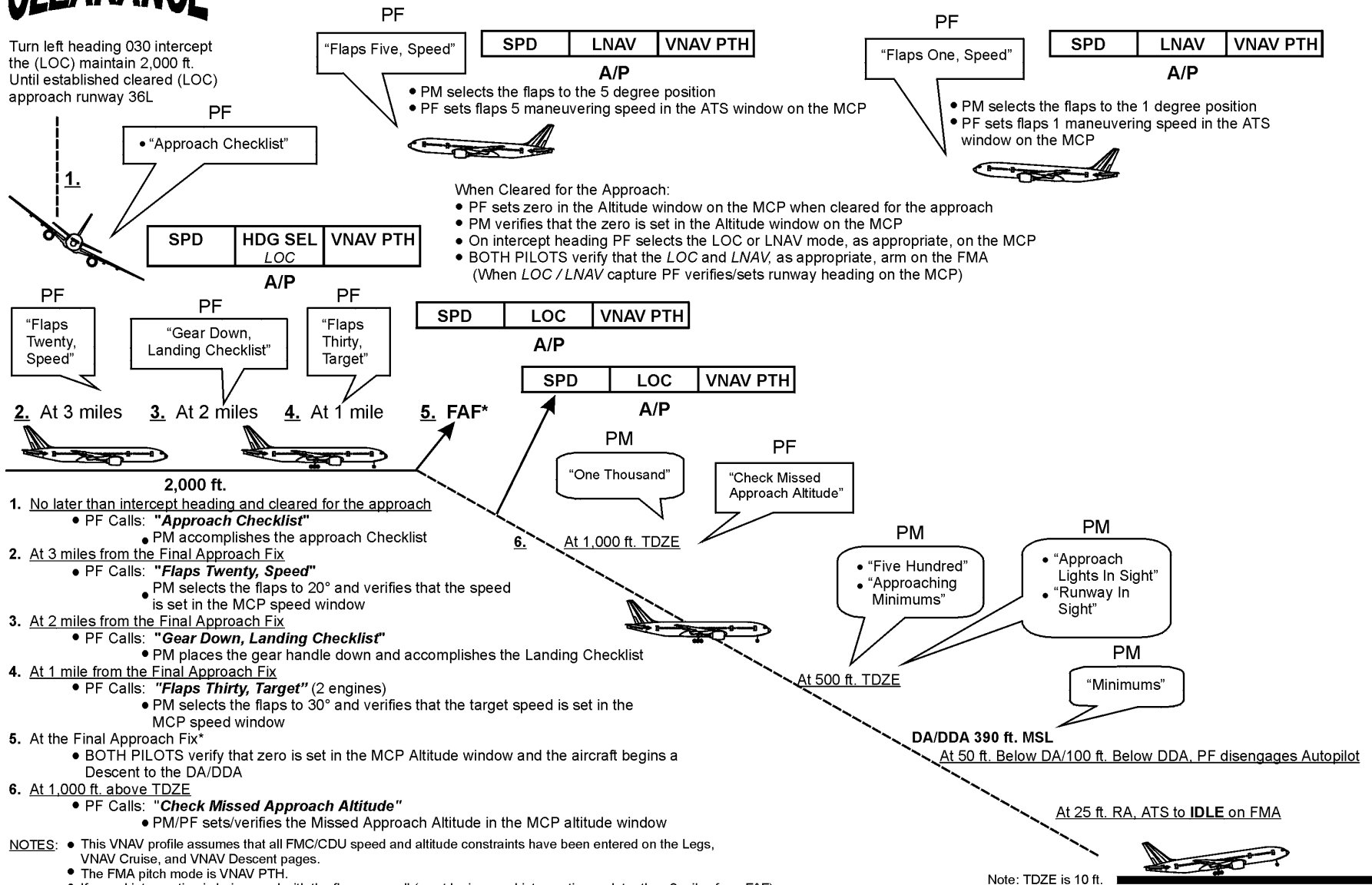
One Engine Inoperative Non-Precision Approach

For one engine inoperative non-precision approach differences, refer to Section 2.7 (Engines & APU Non-Normals) in the B777 Flight Manual under "One Engine Inoperative Approach, Landing and Missed Approach Procedures."

CLEARANCE

Turn left heading 030 intercept the (LOC) maintain 2,000 ft. Until established cleared (LOC) approach runway 36L

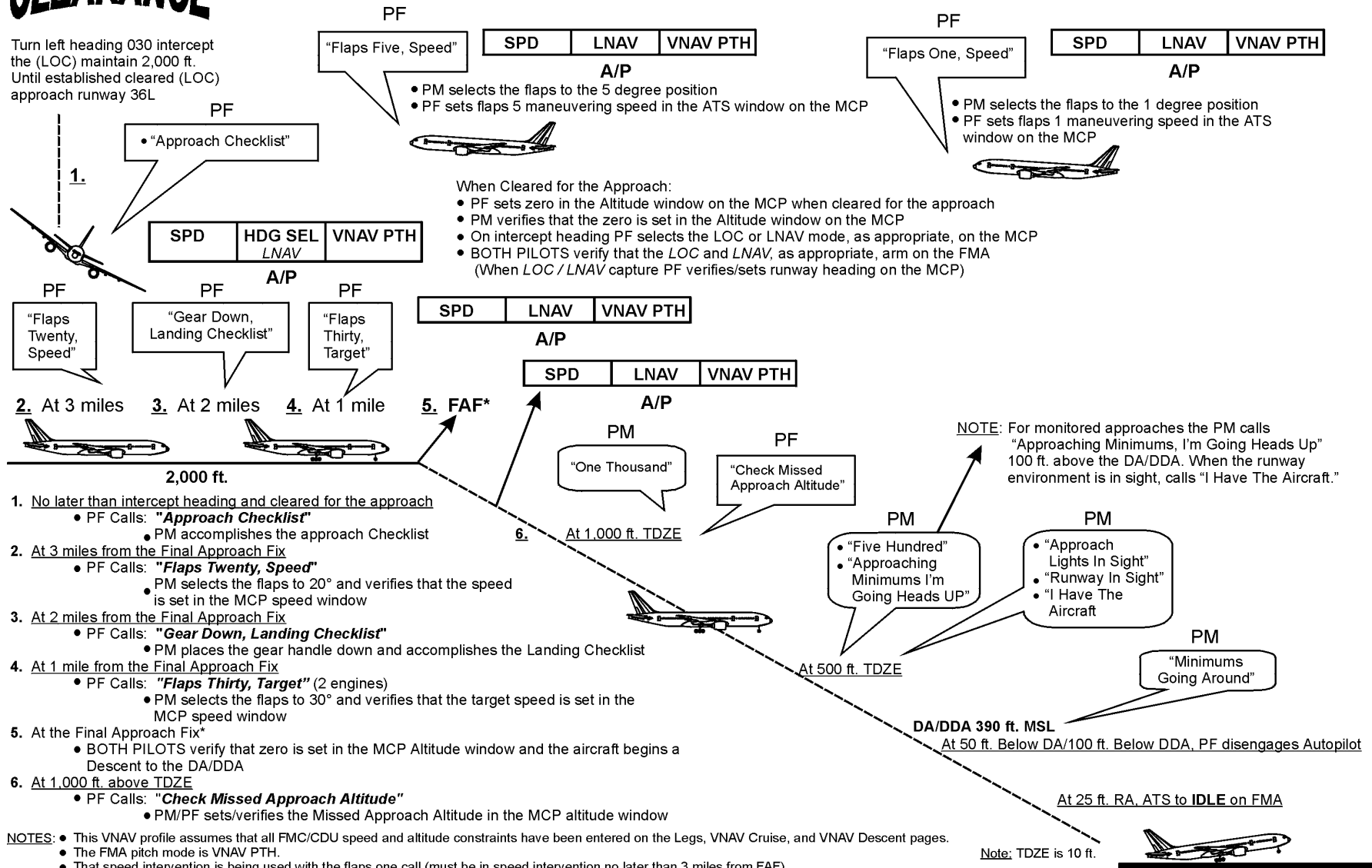
Non Precision Approach Coupled Profile (VNAV)



CLEARANCE

Turn left heading 030 intercept the (LOC) maintain 2,000 ft. Until established cleared (LOC) approach runway 36L

Non Precision Approach Coupled/Monitored Profile (VNAV)



FMC SET-UP		CALLOUTS	
IF NPA Stored in Nav Database (VOR, LOC, LOCBC, RNAV): ↑ DEP/ARR - 1. Select NPA (and Transition if appropriate). RTE LEGS - 1. Enter TGT speed for FAF. OR 2. Do not change altitudes for approach waypoints from the FAF inbound. ↓ NAV RAD - 1. NDB Freqs as req. Select ADF/VOR switches. (Allow VORs to autotune.)		Pilot Monitoring (PM)	Pilot Flying (PF)
IF NPA Not Stored in Nav Database - (NDB, ILS G/S out, GPS): DEP/ARR - 1. Select overlay approach with same lateral track inside FAF. (ILS or RNAV for same runway and Transition if appropriate) RTE LEGS - 1. Modify lateral segment outside FAF as necessary. 2. Verify/enter correct altitude for FAF. 3. Enter TGT speed for FAF. 4. Note any differences in Missed Approach Procedure. NAV RAD - 1. NDB Freqs as req. Select ADF/VOR switches. (Allow VORs to autotune.)		Above TDZE "1000" "500" (as req'd by DA/DDA) (100' ABOVE DA/DDA) "APPROACHING MINIMUMS" (At DA/DDA) "MINIMUMS" "400" "300" "200"	"CHECK MISSED APPROACH ALTITUDE" If a missed approach is required the callouts are: ↓ "MINIMUMS, GOING AROUND", "FLAPS TWENTY (or FIVE)", "CHECK POWER", "POSITIVE RATE, GEAR UP", "CHECK MISSED APPROACH ALTITUDE", "LNAV or HDG SELECT" (400'), "CHECK TOP BUG" (800' or 1000').
DETERMINE MINIMUMS FOR THE APPROACH			
Published Minimums = DA: Use DA as published Published Minimums = MDA: Compute DDA (MDA + 50 ft.) 1. Set Baro Mins on EFIS Control Panel. 2. Verify/modify RNP (POS REF pg 2 of 3). Note: MDA may be used as DA if authorized by ball note on chart.			
WHEN FLAP EXTENSION INITIATED		LANDING PROCEDURES	
MCP - Select VNAV with Speed Intervention 1. Push VNAV switch (closes MCP airspeed window). 2. Push Airspeed Select Knob (opens MCP airspeed window). 3. Select desired speed for configuration.		1. To continue below minimums the crew must have at least one of the following: a. Approach Light System (below 100' red terminating or red side row bars must be identifiable). b. Threshold, threshold markings, threshold lights. c. REILS. d. Touchdown zone, touchdown zone markings, or lights. e. Runway or runway markings. f. Runway lights. Note: A/P must be disconnected no later than 50' below DA (100' below DDA). Caution: Under no circumstances will a landing be attempted after a go-around is initiated.	
WHEN CLEARED FOR APPROACH			
Note: If on assigned heading: Intc Course To - Select appropriate approach waypoint when on vectors for approach. MCP - 1. Verify VNAV annunciated then set zero in MCP Altitude Select Window. 2. Select Roll Mode as appropriate: LOC for Localizer, ILS G/S out, or LDA approach; LNAV for all other approaches. FMA - 1. Ensure VNAV PTH indication no later than FAF passage.			

**Required with visibility reported or anticipated below:
1 sm or less (5000 RVR or less)**

CALL OUTS FOR NON-PRECISION MONITORED APPROACH

CAPTAIN (PM)

Above TDZE

"1000"

"500" (as req'd by DA/DDA)

At 100 ft. above DA/DDA:

**"APPROACHING MINIMUMS
I'M GOING HEADS UP"**

At decision to descend below DA/DDA:

"I HAVE THE AIRCRAFT"

After taking control of aircraft
Captain will execute go around
if required.

FIRST OFFICER (PF)

"CHECK MISSED APPROACH ALTITUDE"

At Minimums and the Captain HAS taken
control of the aircraft:

"MINIMUMS"

If the Captain HAS NOT taken control
of aircraft:



**"MINIMUMS, GOING AROUND",
"FLAPS TWENTY (or FIVE)",
"CHECK POWER",
"POSITIVE RATE, GEAR UP",
"CHECK MISSED APPROACH ALTITUDE",
"LNAV or HDG SELECT",
"CHECK TOP BUG" (800' or 1000').**

AUTHORIZED RVR - FEET AND METER EQUIVALENTS

FEET	2400	3000	4000	4500	5000	6000
METERS	750	1000	1200	1400	1500	1800

Performance Limits

Raw Data verification:

1. LOC, LOCBC, ILS G/S out: +/- 1 dot.
2. VOR +/- 5 degrees or 1 dot.
3. NDB +/- 5 degrees.

RNAV -

1. EICAS - no "NAV UNABLE RNP".
2. Aircraft symbol touching track line on ND in 10 nm scale.

VPDS -

1. No VPDS by FAF execute missed approach.
2. Brief alternate pitch mode of FPA or V/S and fly second approach to DA/DDA.
3. Fly approach to DA/DDA using FPA or V/S regardless if VPDS is displayed.

ILS PRECISION RUNWAY MONITOR (PRM) PROCEDURES

In Range

1. Review Jepp 11-0 PRM instructions and planned PRM approach plate.
2. The following systems must be operational:
 - a. ILS (Cat I);
 - b. Transponder;
 - c. Two VHF radios.
3. Advise ATC if unable to perform PRM approach.

Approach

1. Set PRM Monitor freq in #2 VHF. Adjust VHF 1 & 2 volume to ensure both pilots hear both radios.
2. Both pilots monitor both radios, transmit only on tower frequency.
3. Unless contrary to Jepp 11-0 PRM instructions, leave TCAS in TARA.
(If TCAS RA and ATC traffic alert occur simultaneously, follow RA climb / descent and ATC turn.)

Flight deck duties in event of "PRM Breakout":

Pilot flying (PF)

1. Immediately disconnect the A/P and manually fly to assigned heading and altitude.
2. **Do not** disconnect the A/T's.
3. **Do not push TOGA.**
4. Do not change configuration (flaps or gear) until established on new heading.
5. A/P may be re-engaged after established on new heading and PM confirms MCP reprogrammed.

Pilot Monitoring (PM)

1. Turn both F/D switches OFF.
2. Set the assigned heading and altitude in the MCP.
3. Turn both F/D switches ON.
4. Push FLCH.
5. Push HDG SEL.
6. Advise the PF that the MCP has been reprogrammed.

VISUAL APPROACH

General

A visual approach is conducted under an IFR flight plan. It allows the pilot to proceed visually to the airport without following a prescribed approach procedure. If the aircraft being followed is in sight, the pilot is responsible for visual separation from other aircraft and wake turbulence avoidance.

Visual Approach Procedures

Thrust

Use thrust for speed control in coordination with the elevators to control attitude, rate of descent, and approach profile.

Adjust thrust slowly and in small increments. Large, sudden thrust changes are indicative of an unstable approach and the related trim changes will make aircraft control more difficult. However, due to the low drag of the airplane, close attention to speed and thrust control is necessary.

A thrust increase may be required when stabilizing on speed with landing gear and flaps extended on final approach.

Downwind and Base Leg

Fly at an altitude of 1,500 feet above the runway elevation with flaps 5 and Flaps 5 V_M speed.

If a 180° turn to final is required, maintain a track parallel to the landing runway approximately 1½ miles abeam.

Prior to turning base leg:

- Position the flaps to 20
- Slow to V_M Flaps 20 speed
- Extend the landing gear
- Call for the LANDING checklist.

Approximately 30 seconds after passing the landing end of the runway (about 45° off the tail):

- Commence the turn to base leg
- Adjust the thrust to descend at 600-800 FPM.

Prior to turning final:

- Extend landing flaps and adjust to target speed.

During extension to landing flaps hold the same approximate pitch attitude and anticipate trim changes.

If a large turn to final is not required approximately 5 miles from the end of the runway and 1,500 feet AGL:

- Position the flaps to 20
- Slow to V_M Flaps 20 speed
- Extend the landing gear
- Call for the LANDING checklist.
- Adjust the thrust to start a descent of 600-800 FPM.
- Extend landing flaps and slow to target speed.

Final Approach

The recommended landing glidepath profile for a visual approach is approximately $2\frac{1}{2}$ to 3 degrees.

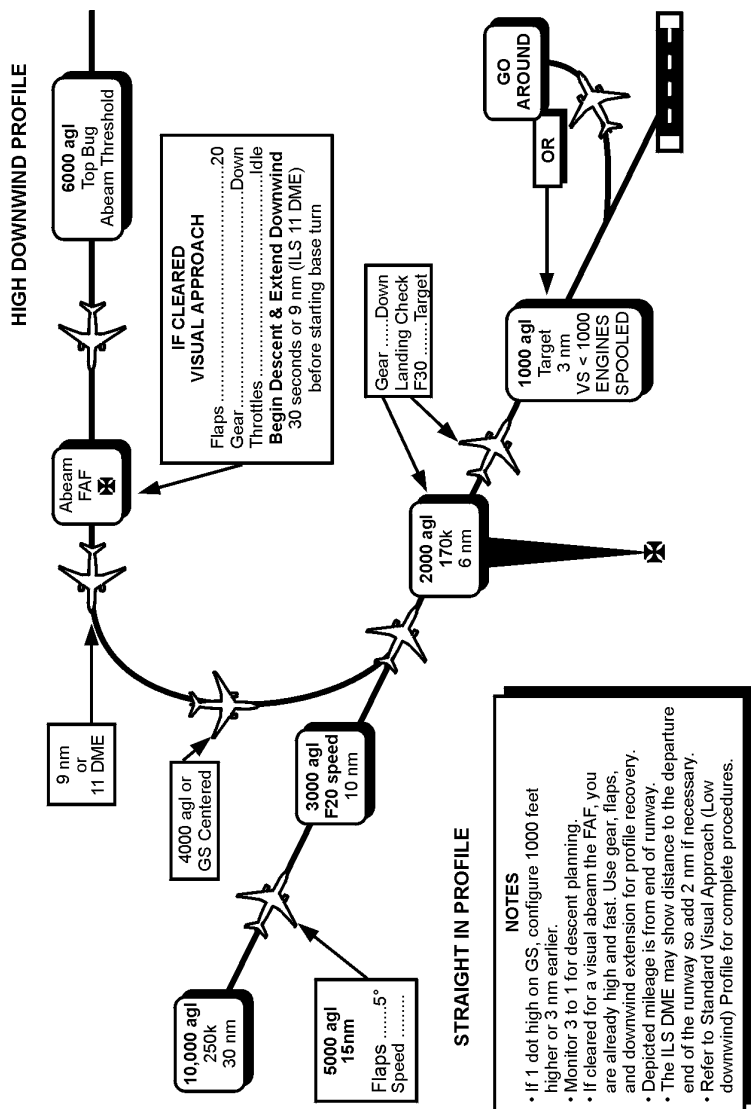
Once the final approach is established, the airplane configuration remains fixed and only small adjustments need be made to maintain glidepath and runway alignment.

Thrust changes should only be made to hold target speed and the desired rate of descent (approximately 600 to 800 feet per minute).

Retrim the stabilizer as necessary to maintain a zero elevator force.

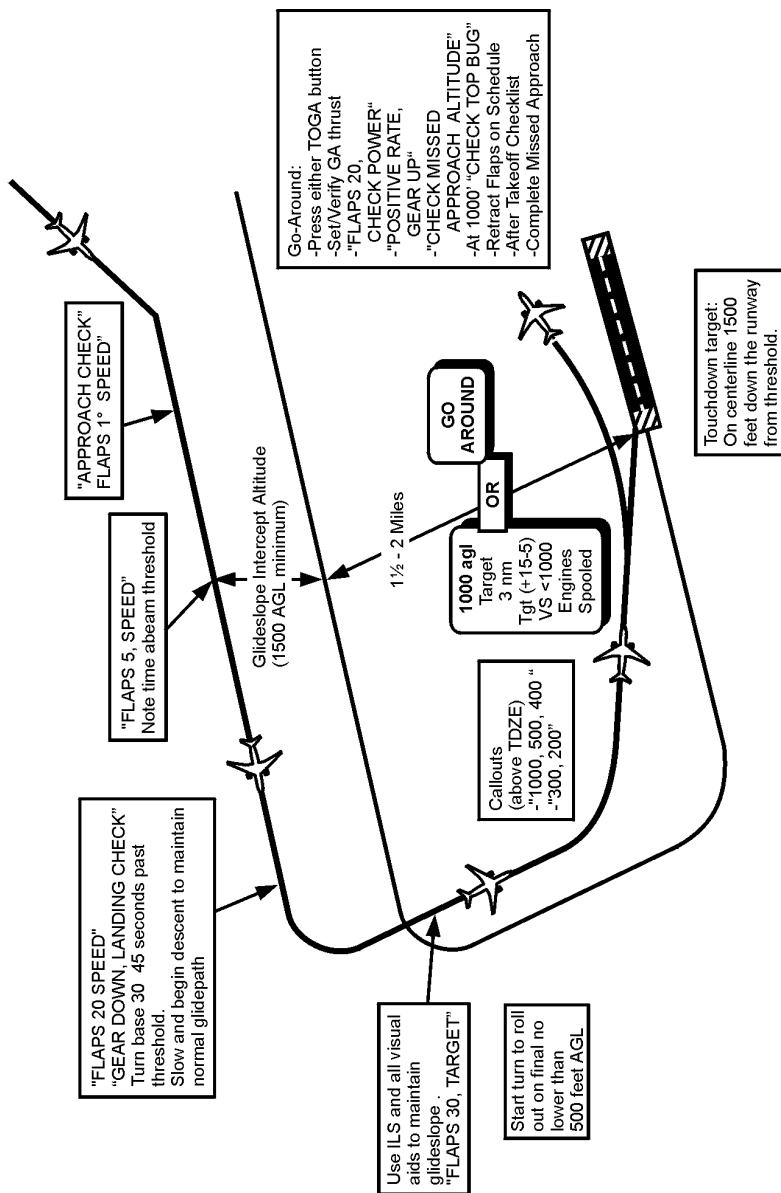
The approach must be flown using “stabilized approach” parameters. (See LANDING PROCEDURES for more information.)

Visual Approach Planning & Gates, High Downwind And Straight In Profiles



Visual Approach Planning & Gates, Low Downwind Profile

LOW DOWNWIND PROFILE



VNAV OPERATION - APPROACH

The VNAV Approach phase of flight normally begins when the flaps are out of UP, or at the first altitude constraint in the selected approach. If the aircraft were flown in pure VNAV (MCP altitude window blank), it would descend in the FMA pitch mode of **VNAV PTH** as long as it was on the computed VNAV descent path and did not encounter a flap / gear limit speed or ATC altitude constraint.

Since it is standard procedure on the B777 to fly all approaches using speed intervention, the crew must understand why the aircraft descends in **VNAV SPD** sometimes and **VNAV PTH** at others. The reason is whether or not VNAV has transitioned from the Descent phase to the Approach phase.

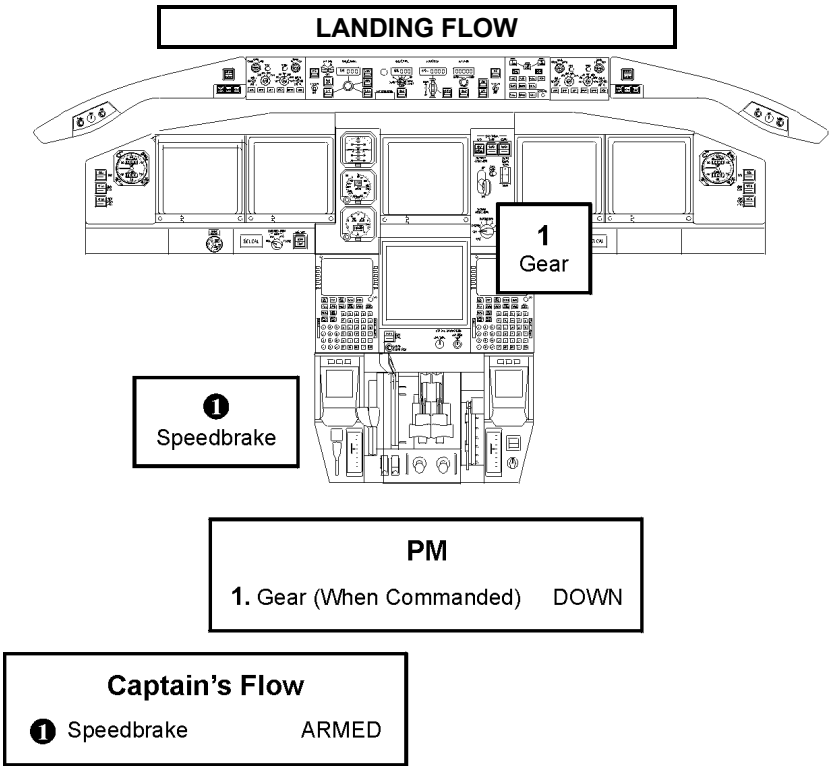
The major observed difference when operating in the VNAV Approach phase is that the FMA pitch mode indicates **VNAV PTH** instead of **VNAV SPD** in a descent with the MCP speed window open (speed intervention).

VNAV transitions to the Approach phase depending upon the arrival procedures utilized.

- The most frequently encountered transition occurs when the aircraft passes overhead or abeam the first approach waypoint / fix (identified at 6R, XXX INTC, on the ARRIVALS page) of an FMC approach (ILS, VOR, etc.); or captures the waypoint / fix altitude constraint.

Note: If the first approach waypoint / fix is replaced with another waypoint fix, the VNAV Approach phase begins when the aircraft passes overhead / abeam or captures the altitude constraint of the next waypoint.

- Another, less frequently encountered situation that defines the transition to the Approach phase is when the distance is 12 miles from the runway for an approach that is straight in.



LANDING

The PF will call for the LANDING Checklist in conjunction with the “GEAR DOWN” call on all normal landings. The PM completes the procedures and the checklist below.

PM Challenge	LANDING	PM Respond
Speedbrake		ARMED
Gear		DOWN
Flaps.....		

<u>PM Challenge</u>	<u>PM Respond</u>
Speedbrake	ARMED

Place the speedbrake lever in the ARMED position, the EICAS message **SPEEDBRAKE ARMED** is displayed. If the EICAS advisory **AUTO SPEEDBRAKE** message is displayed, disarm the speedbrake, and use manual speedbrake for landing.

Gear..... DOWN

Primary verification of gear position is by the EICAS **GEAR DOWN** (green) normal display.

Flaps _____

The PM will verify the flap position indicator, on the primary EICAS display, corresponds to the flap handle position selected for landing.

GO-AROUND PROCEDURES**General**

A go-around will be initiated if continuation to a safe landing is not possible at DA(H)/AH on a precision approach, at the DA/DDA on a Non-Precision approach, or at any point in the approach that the pilot feels that safety may be compromised if the approach is continued.

If the decision is made to go-around during a circling approach or visual maneuvering, the missed approach specified for the approach procedure utilized to get to the airport must be followed. To become established on the prescribed missed approach course, make an initial climbing turn toward the landing runway and continue the turn until established on the missed approach course.

Go-Around (TO/GA) mode is armed when the flaps are not up or the glideslope is captured. Arming is not annunciated. Go-around is engaged by pushing either TO/GA switch. The mode remains engaged even if the aircraft touches down while executing the go-around. With TO/GA mode engaged, the AFDS controls pitch and roll while the A/T increases thrust as required to establish a 2,000 fpm climb with (GA reference thrust the maximum).

Go-Around Procedure

The following chart defines the go-around procedure. It is based on a go-around from a coupled approach. In the event the approach was manually flown with a flight director, the same procedure may be utilized. However, the throttles must be positioned manually (if autothrottles are disengaged). In the event of a raw data go-around, flight director guidance will be available after pushing either TO/GA switch, and will remain engaged until the roll or pitch TO/GA mode is replaced by another roll or pitch mode.

Initially rotate to 15° nose up and assure the throttles are advanced. In any situation where manual throttle operation during a go-around is required, initially advance thrust to full go-around power. Do not use an intermediate power setting.

Call “GOING AROUND, FLAPS 20, CHECK POWER” and after a positive rate of climb is indicated, call “POSITIVE RATE, GEAR UP, CHECK MAP ALTITUDE.” At 400’ AFE select **LNAV** or **HDG SEL** as appropriate.

Complete the initial missed approach maneuvering, at 1000’ AFE; call “CHECK TOP BUG” and retract the flaps normally.

Note: For go-around after touchdown see REJECTED LANDING this section.

VNAV OPERATION - MISSED APPROACH

The following procedures address the use of VNAV after initiating a missed approach, and are not to be confused with the Autoflight system TO/GA mode.

There are two sets of circumstances after a missed approach; those dealing with diverting to an alternate airport, and those dealing with returning for another approach. Each are addressed separately.

DIVERTING TO ALTERNATE

If diverting to an alternate airport VNAV should be selected after completion of the missed approach procedure. VNAV operates the same as a normal takeoff and climb.

RETURNING FOR SECOND APPROACH

If returning for another approach after a missed approach has been completed, it will be necessary to build the new approach using the DEP/ARR pages. The **XXXX INTC** prompt at 6R may be used if not navigating in LNAV, in a holding pattern, or flying a transition. As for all approaches, the pilot should then build / verify the altitude constraints, if required, and target speed.

Select the VNAV key on the CDU and the VNAV page for the current phase of flight is displayed. If the 240 KT DES page is displayed change the speed on the SEL SPD line to the current airspeed. If the ACT 250 KT CRZ page displays it will be necessary to change the speed on both the ACT 250 KT CRZ and the ACT 240 KT DES page.

Select the VNAV switch on the MCP to engage VNAV.

CAUTION: Selecting VNAV on the MCP without changing the speeds as discussed above results in VNAV engaging at the active CRZ, or DES speed. The autothrottles increase / decrease thrust as required to acquire and maintain that speed.

[A good technique is to hold the throttles and select VNAV on the MCP - the MCP speed window initially blanks. Push the speed selector knob to open the window (speed intervention) and set the desired speed. The throttles may now be released.]

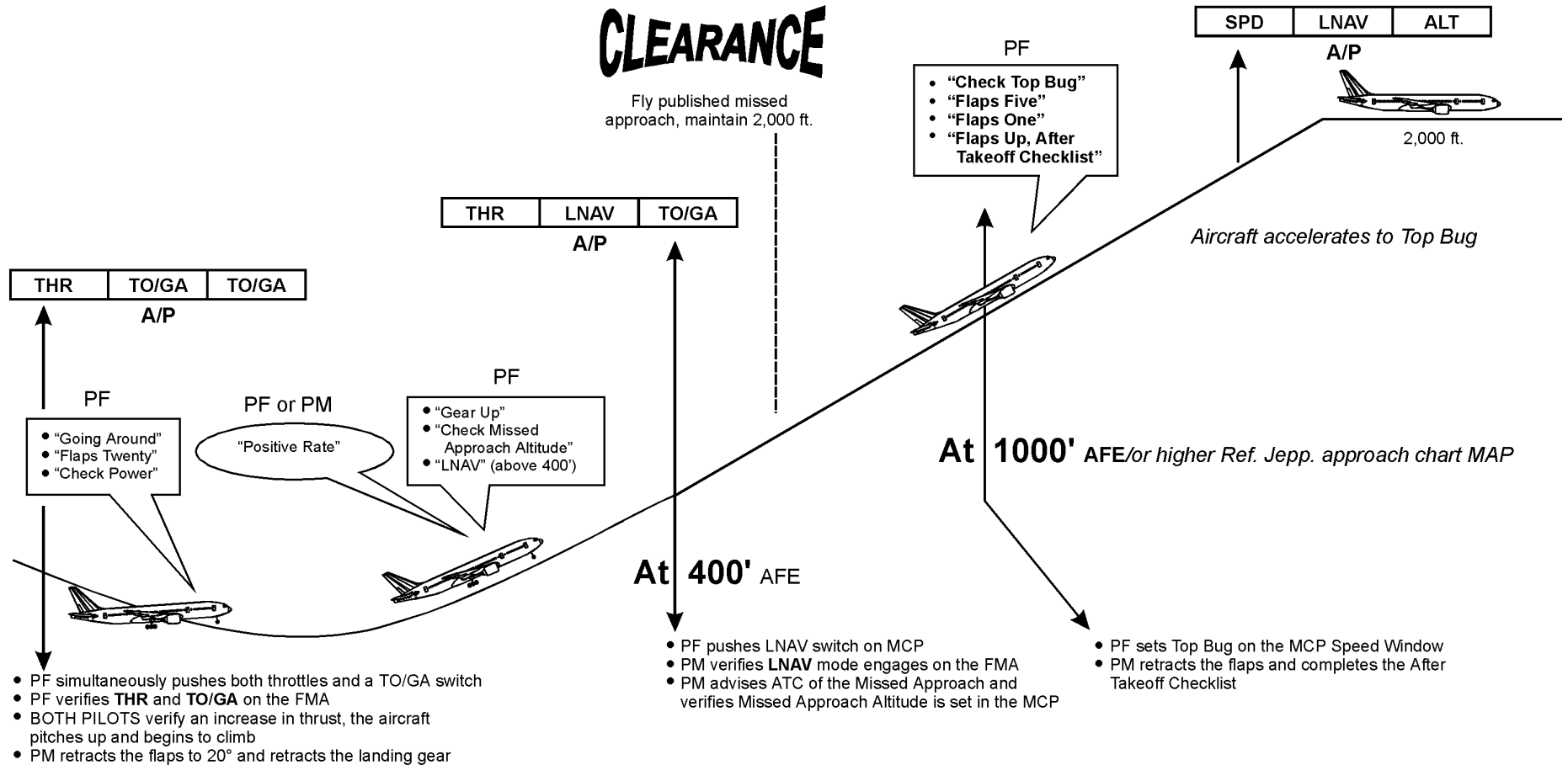
If not flying approach transitions, the XXX INTC function on the ARRIVALS page (6R) should be used for all approaches when on vectors for the approach. Be sure to monitor normal waypoint / fix sequencing. If you pass the first waypoint / fix and it does not sequence (remains magenta instead of changing to white), it will be necessary to do the “Intercept Course To” function on the LEGS page. (No need to change the course at 6R, just select it to make the course number large, then EXECUTE.)

GO-AROUND PROCEDURE CHART GA FROM COUPLED APPROACH

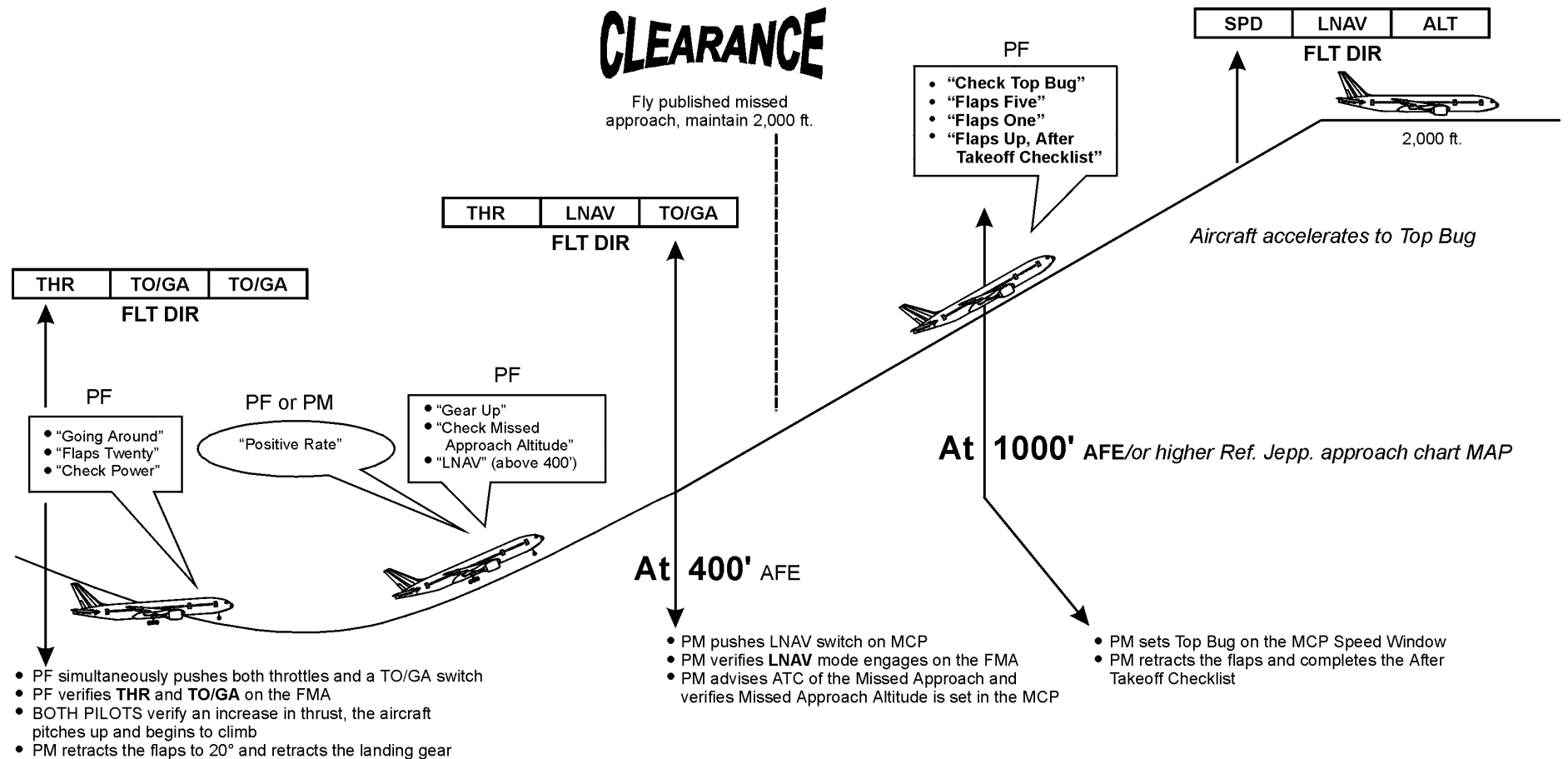
PHASE OF FLIGHT	PILOT FLYING: DUTIES/CALLOUTS	PILOT MONITORING: DUTIES/CALLOUTS	A/T	FMA DISPLAY ROLL	PITCH	AFDS	NOTES
Initiation	Simultaneously: <ul style="list-style-type: none"> Press either TO/GA Switch. Ensure Rotation to initial go-around attitude (15° Nose Up). Ensure throttles move to required thrust. Call "GOING AROUND, FLAPS 20." Call "CHECK POWER." At indication of positive rate of climb, call "POSITIVE RATE, GEAR UP, CHECK MISSED APPROACH ALTITUDE." 	<ul style="list-style-type: none"> Check for TO/GA Pitch Mode and Roll on FMA. Monitors thrust setting and adjust N₁, as required. Position Flaps and Gear on command and monitor configuration. Call Missed Approach to ATC. 	THR	TO/GA	TO/GA	A/P	<ul style="list-style-type: none"> An automatic go-around mode is enabled when flaps are not up or G/S is captured and is disabled below 2' RA and enabled 3 seconds after RA.>5'. TO/GA mode engaged on FMA in pitch and roll. The A/T increases thrust for GA; roll commands bank to maintain ground track. AFDS increases pitch to hold the greater of MCP command or current speed position, to a max of IAS/MACH window +25. When 2000-fpm climb established, A/T controls thrust to maintain climb rate.
400' AFE	<ul style="list-style-type: none"> Select the desired Roll Mode (HDG SEL or LNAV). Ensure that missed approach waypoints have been entered on the CDU prior to the approach. 	<ul style="list-style-type: none"> Monitor desired Roll Mode in FMA. Assist and monitor as required to execute the MAP. 	THR	HDG SEL / LNAV	TO/GA	A/P	<ul style="list-style-type: none"> When roll mode changed from TO/GA, autopilot control of rudder ends.
1000' AFE	<ul style="list-style-type: none"> "CHECK TOP BUG." Call for flap retraction on flap speed schedule. Call for "AFTER TAKEOFF CHECKLIST" after the "FLAPS UP" call. 	<ul style="list-style-type: none"> Verify MCP speed bug to V_{REF} 30 + 80. Retract Flaps on command. Back up PF during MAP to ensure airspeed and NAV procedure compliance. 	THR	HDG SEL / LNAV	TO/GA	A/P	<ul style="list-style-type: none"> Speed control is provided in the TO/GA mode so it is not necessary to select VS or FLCH modes for acceleration when climbing to missed approach altitude.
Level Off	<ul style="list-style-type: none"> Monitor ND for MAP profile concurrence. 	<ul style="list-style-type: none"> Monitor ND for MAP profile concurrence. 	SPD	HDG SEL / LNAV	ALT	A/P	<ul style="list-style-type: none"> At the selected altitude the TO/GA pitch mode is disengaged, and the A/T SPD mode is engaged automatically.

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Go Around/Missed Approach Coupled Profile (LNAV)



Go Around/Missed Approach Manual Profile (LNAV)

Notes:

1. Go-Around speed is MCP target speed, current speed or target speed + 25 Kts. Maximum.
2. Pushing a TO/GA switch again will increase thrust limit to GA and ATS **THR REF** mode will be on the FMA.
3. At 400 ft. PF may call for **HDG SEL/TRK SEL** on the MCP if MAP is not programmed in FMA
4. If the Missed Approach Altitude is captured before setting Top Bug, thrust will increase to **GA** limit and the commanded speed is 5 Kts. below the selected flap placard speed.
5. PF may elect to say ("Check Flaps Five Speed") and retract the flaps to 5°, or say ("Check Flaps One Speed") and retract them to 1° if returning for another approach.

LANDING PROCEDURES**Landing Flap Selection**

A flaps 30 configuration is recommended when conditions permit. This will provide additional aft body clearance from the runway when compared to a flaps 25 landing. All flights are dispatched for flaps 30 landing.

Stabilized Approach

The illustrated pattern represents the ideal approach situation. Flap and landing gear extension points were selected to minimize crew workload and thrust changes during the approach.

The most optimum and consistent landing performance is achieved through the use of a stabilized approach. A Stabilized Approach is defined as flight on the desired glide path, visual or electronic, at a steady rate of descent, on the “target” approach speed in landing configuration, in trim, and with the proper thrust setting. Approach planning which results in a stabilized approach at and below 1000’ above field elevation will provide the most consistent landing performance.

Approaches will be considered unstable, and shall result in a missed approach if:

- The airspeed is greater than +15 knots or greater than -5 knots from target speed
- Vertical speed is greater than 1000’ per minute
- Engines are less than minimum spooled, 45% N_1 .

For wide body aircraft these parameters must be met for all operations before reaching 1000’ above touchdown zone elevation, or a go-around will be announced by the PM.

While continuing the approach (below the BOTTOM LINE altitude stated above), it must be understood that the aircraft must be correcting and trending toward the desired stable condition. Deviations from the optimum should be called out by the PM.

Maneuver Margin

Flight profiles should be flown at the recommended maneuvering speed for the existing flap configuration. This speed allows full maneuvering capability.

Full maneuver margin exists for all normal and non-normal landing procedures and during all go-arounds whenever speed is at or above the maneuver speed for the current flap setting. $V_{REF} 30 + 5$ with flaps 20 allows full maneuver margins.

Final Approach

Once landing flaps have been established, target speeds (under stable air conditions) will be $V_{REF} + 5$ knots with autothrottles engaged. However, the decrease in wind velocity approaching the surface of the earth has the effect of a decrease in aircraft velocity. Consequently, caution must be exercised to prevent airspeed bleed off and increased sink rate during the last stage of the approach.

Autothrottles-off target approach speed is $V_{REF} + 5$ knots for landing in reported winds of zero to light and variable (up to 10 knots). When landing in higher wind conditions, add 1/2 the steady headwind component and the full value of the gust to V_{REF} . The total wind additive should not exceed 20 knots.

The A/T design features include automatic gust compensation; therefore, it is not necessary to set gust or wind speed corrections on the speed selector when the autothrottle is used throughout the final approach. The system will handle the normal wind conditions encountered during the final approach and landing. However, flight crews must be alert for any unusual conditions such as windshear and be ready to take manual control of the aircraft to complete the approach and landing or execute a go-around.

The pilot should aim for a constant angle relationship to a point 1,500' down the runway, coordinating pitch attitude and power changes. As the end of the runway disappears under the nose, maintain this stabilized attitude and power setting until the flare point is reached.

The pilot should restrain himself from the tendency to dive at the runway when breaking clear of the clouds at low altitude under instrument conditions, or as the end of the runway disappears under the nose in visual flight conditions. The high rates of sink that develop with this maneuver are not readily apparent on the airspeed indicator and may not be noticed until the flare point.

Visual Aim Point

With the main gear so far behind the pilot's eyes, it is more difficult to judge the flare and touchdown points. In the B777, the difference in gear path and eye-level path has increased because of the longer wheelbase and the increased flight deck height. Consequently the main gear will not touch down on the runway at the selected visual aim point. Visual aim points versus gear touchdown point difference increases as glide path angle decreases as in a flat approach. For a particular visual approach, the pilot must account for the difference between gear path and eye level path in the B777. A visual aim point approximately 1500' beyond the threshold is recommended.

Note: The visual aim point is not where the aircraft will touch down, but is pilot eye orientation with the runway. Although the actual touchdown point will vary with the flight-path angle, the touchdown will not be short or unnecessarily long if the recommended 1500 foot visual aim point is used.

Threshold Height

Threshold height is a function of glide path angle and landing gear touchdown target. During a typical 3° visual approach, with a 1,000 foot touchdown, the main landing gear will cross the threshold at approximately 50'. Special attention must be given to establishing a final approach that will assure safe threshold clearance and gear touchdown at least 1,000' down the runway. Recommended standard callouts will assist the pilot in determining a proper profile.

The main landing gear touchdown points, shown on the ILS and Visual Approach Approximate Touchdown Point diagrams in this section, assume no flare.

For Non-Category II ILS installations, a transition from the ILS glideslope to a visual glideslope should be made between decision height and 100'. A visual aim point approximately 1500' down the runway will provide a 40 to 60 foot threshold clearance and a touchdown point about 1200 to 1300' down the runway.

The Radio Altimeter is biased to accurately indicate the height of the lowest part of the main wheels above the terrain. Therefore, the Radio Altimeter is very valuable in determining wheel height. The GPWS-activated annunciation's of radio altitude from 100' to 10' AGL, along with visual cues, will give the PF a good assessment of the final stages of his/her approach, flare, and landing.

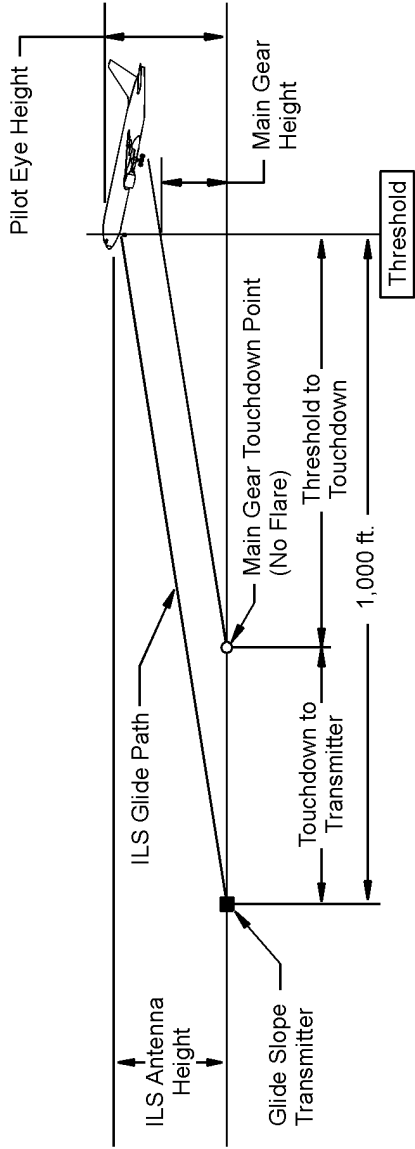
Approach Summary

- The use of proper procedures will result in consistently safe and satisfactory approaches, and will preclude short landings.
- When using two-bar VASI the differences between the eye reference path and the gear path of the B777 results in a low approach with marginal threshold height. It may provide useful information in alerting the crew to low profile situations. Do not use the two-bar VASI for guidance on a visual approach below 300'. That glide path would cause a threshold crossing height lower than desired.
- The three-bar VASI may be used realizing the characteristics and limitations of this system.
- The aircraft must not be flown below the glideslope when approaching the threshold on an ILS approach.
- If the threshold is still readily visible over the nose at 50' radio altitude over flat terrain, it is a positive indication that the aircraft is too low.

Approach and Landing Geometry

The following profiles and tables show the relationships between ILS glideslope profiles and two/three-bar VASI profiles and the resulting threshold crossing heights and landing gear touchdown points (assuming no flare).

ILS Final Approach and Landing Geometry



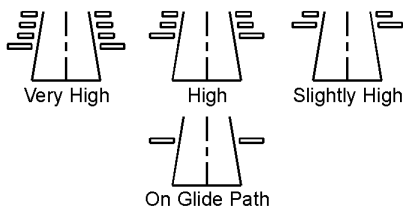
Conditions	Glide Path (degrees)	Airplane Body Attitude (degrees)	Threshold Height		Pilot Eye Height (feet)	Threshold to Main Gear Touchdown Point - No Flare (feet)	Main Gear Touchdown Point to Glideslope Transmitter (feet)
			Main Gear (feet)	ILS Antenna (feet)			
0 VREF + 5 kt All heights and distances relative to the threshold ILS Glideslope transmitter at 1000 ft.	2.5	2.0	24.4	44.0	56.4	558.0	442.0
	3.0	1.5	32.8	52.4	64.8	625.1	374.9

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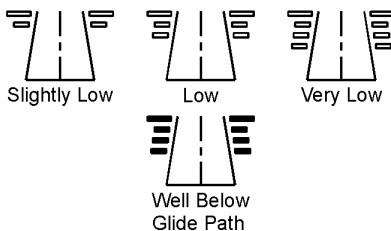
Visual Approach Slope Indicator (T-VASI)

■ Red T-VASI Lights
□ White T-VASI Lights

Fly Down Lights



Fly Up Lights



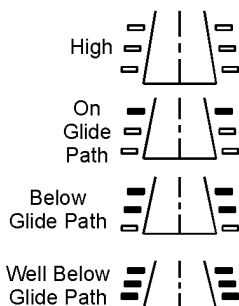
7773031

T-VASI LANDING GEOMETRY 777

Visual Approach Slope Indicator (VASI)

■ Red VASI Lights
□ White VASI Lights

WIDE BODY AIRCRAFT (3-bar)



7773031A

3 BAR VASI LANDING GEOMETRY 777

Flare and Landing

During a typical 3° ILS glideslope approach or a visual approach using the 3-Bar VASI system, the main landing gear should cross the runway threshold at approximately 50'. This results in main wheel touchdown at approximately 1000'. Do not deviate from the glide path in an attempt to touchdown sooner.

When using two-bar VASI the difference between the eye reference path and the gear path of the 777 results in a low approach with marginal threshold height. Therefore, the two-bar VASI system should not be used to determine proper approach profile. It may provide useful information in alerting the crew to low profile situations.

Crossing the threshold, shift the visual sighting point to approximately 3/4 of the way down the runway length, while maintaining descent. This will assist in determining the flare point. Initiate the flare when the main gear (RA) is approximately 20' above the runway by increasing pitch attitude approximately 2°. This will slow the rate of descent. After the flare is initiated, smoothly retard the thrust levers to idle, and make small pitch attitude adjustments to maintain the desired descent rate to the runway. Ideally, main gear touchdown should occur simultaneously with thrust levers reaching idle. A speed bleed off during the flare of 3 to 4 knots, and a touchdown attitude of 4° to 5° is normal. Do not use pitch trim during flare or after touchdown. Do not allow the aircraft to float. Fly the aircraft onto the runway and accomplish the landing roll procedure.

Typically, the pitch attitude will increase slightly during the actual landing, due to spoiler deployment, but avoid over-rotating. Do not increase the pitch attitude after touchdown; this could lead to a tail strike. Avoid over-rotating in response to the pitch change. Most tail strikes occur 2 - 3 seconds after touchdown at a pitch attitude of 8° – 10°. Use of autobrake will reduce the tendency to pitch-up (due to spoiler deployment) on touchdown.

Shifting the visual sighting point down the runway assists in controlling the pitch attitude during the flare. Hold sufficient back pressure on the control column to keep the pitch attitude constant.

Avoid rapid control column movements or trimming during the flare to avoid increasing the pitch attitude after touchdown. Such actions are likely to cause pitch to increase at touchdown and increase the potential for a tailstrike. Do not allow the aircraft to float. Fly the aircraft onto the runway and accomplish the landing roll procedure. Do not attempt to extend the flare by increasing pitch attitude in an attempt to achieve a perfectly smooth touchdown. Do not attempt to hold the nose wheel off the runway.

If the aircraft nose up attitude is excessive during landing, fuselage contact is possible. Factors resulting in excessive nose up attitude are early or high flare, early thrust reduction, low airspeed or rapid speed reduction during flare, holding the aircraft off the runway in an attempt to achieve a soft landing, and trimming the stabilizer nose up just prior to touchdown.

Caution: A landing with the speedbrake extended (not authorized) will almost assure aft fuselage contact with the runway.

The Landing Flare Profile in the following diagrams show a normal approach and touchdown.

Autoland

The automatic landing is almost identical to the manually flown landing. Although the automatic flare mode is engaged at 40' - 60', the pitch attitude does not change appreciably until 25' - 50' radio altitude. The autothrottle is programmed to gradually reduce thrust, reaching idle thrust at touchdown.

Autoland At Non-Category II/III ILS Installations

The autoland system gives optimum performance on ILS installations of Category II or better standards. On ILS installations of lower standards, localizer and glideslope signal quality and terrain features vary markedly. Perhaps more important is the fact that landing gear threshold clearance may not be assured because of the location of the glideslope transmitter and/or the angle of the glideslope. The autoland system can be used on non-Category II ILS installations, but the flight crew must be aware of the factors that will ensure acceptable operation with adequate terrain and threshold clearance.

Certain features of the Category II ILS installations ensure optimum performance for the autoland system. They include localizer and glideslope quality, signal interference protection from ground vehicles and aircraft, glideslope angle, glide path intercept point (GPI) with the runway, and final approach area terrain.

Non-Category II ILS installations have less stringent requirements. The localizer and glideslope beams may be less stable. There is no requirement for localizer and glideslope signal protection from local distortion. Terrain in the final approach area may not be suitable for the autoland system. Localizer and glideslope automatic monitoring and switch over to backup equipment may not be available.

The autoland system uses radio altitude to reduce autopilot response to both localizer and glideslope deviations, and to trigger various functions during the final approach. During the flare maneuver vertical acceleration, radio altitude, and rate of change of radio altitude, are used to control the flare profile and to compensate for the decreased rate of descent caused by increasing ground effect. Thus, it can be assumed that the approach area terrain is a significant factor in autoland performance.

The optimum situation would be to have level terrain from the 1,500 foot radio altitude point to the glideslope GPI in order to have optimum controlled gain programming plus good flare profile acquisition. Good autoland performance is obtainable with relatively level terrain from the 100 foot radio altitude point to the glideslope GPI. This will allow good flare profile acquisition.

Autoland performance on non-Category II ILS installations may tend to be somewhat erratic. The pilot is the monitor. He/She should closely monitor the approach and flare progress and be prepared to immediately revert to manual control of the aircraft in any questionable situation.

Autoland Approach Procedure

The AFDS status annunciation must indicate either **LAND 3** or **LAND 2** for a landing incorporating autoland. The aircraft is certified to land using either flaps 20 or flaps 30.

Note: The B777 is not certified for autolandings at weights in excess of Max Landing Weight.

At 500' (baro), the flight crew should verify that **LAND 2** or **LAND 3** is annunciated in the AFDS. The PM will call "500," and the PF will respond with the AFDS annunciation of either "LAND 3" or "LAND 2." Standard altitude callouts will be made throughout the approach. When passing approximately 40' - 60' RA, the FMA should indicate **FLARE**. At less than 2' RA, the FMA should indicate **ROLLOUT**.

Note: If either the **FLARE** or **ROLLOUT** FMA indications are not annunciated, and the weather conditions are Category I or better, the PF may disconnect the autopilot and manually land the aircraft. Category II and III approaches require an autoland.

Following touchdown, the autopilot will lower the nose to the ground and track the runway centerline. The PF should apply reverse thrust and PM should monitor the rollout.

The autopilot should be disconnected prior to attempting to steer the aircraft with nosewheel steering.

Note: Attempts to override the rudders during rollout can cause the autopilot to disconnect.

Crosswind Landing

See Section 1, Limitations, for crosswind landing capability.

Four methods of performing crosswind landings are presented. They are the sideslip, de-crab technique (with removal of crab in flare), crab technique for slippery runways and combination crab/sideslip technique. Whenever crab is maintained during a crosswind approach, offset the flight deck on the upwind side of the centerline so that the main gear touches down in the center of the runway.

Sideslip

The sideslip crosswind technique aligns the aircraft with the extended runway centerline, so that main gear touchdown occurs in the center of the runway.

The initial phase of the approach to landing is flown using the crab method to correct the drift. Prior to the flare the aircraft centerline is aligned on or parallel to the runway centerline. Downwind rudder is used to align the longitudinal axis to the desired track as aileron is applied into the wind to prevent drift. A steady sideslip is established, with opposite rudder and low wing into the wind to hold the desired course.

Touchdown is accomplished with the upwind wheels touching just before the downwind wheels. Overcontrolling the roll axis must be avoided because overbanking could cause the engine nacelle or outboard wing flap to contact the runway.

Properly coordinated, this maneuver will result in nearly fixed rudder and aileron control positions during the final phase of the approach, touchdown, and beginning of the landing roll.

De-Crab During Flare

The objective of this technique is to maintain wings level throughout the approach, flare, and touchdown. On final approach, a crab angle is established with wings level to maintain the desired course. Just prior to touchdown while flaring the aircraft, downwind rudder is applied to eliminate the crab and align the aircraft with the runway centerline.

As rudder is applied, the upwind wing will sweep forward, developing roll. Hold wings level with simultaneous application of the aileron control into the wind. The touchdown is made with cross controls and both gear touching down simultaneously. Throughout the touchdown phase, upwind aileron application is utilized to keep the wings level.

Touchdown In Crab On Slippery Runways

On very slippery runways the crosswind crab angle may be maintained to touchdown. This will reduce drift toward the downwind side when touching down. Since the aircraft does not have to be de-crabbed, pilot workload is reduced. Proper rudder and upwind aileron must be maintained to ensure that directional control.

Combining Crab And Sideslip

It may be necessary to combine crab and sideslip during strong crosswinds. Main gear touchdown is made with the upwind wing low and crab angle applied. As the upwind gear touches first, a slight increase in downwind rudder is applied to straighten the nose. A simultaneous application of aileron is applied to maintain wings level.

Land And Hold Short Of (LAHSO) Clearance

Refer to CAL Operations Manual.

Bounced Landing

In the event of a bounced landing, hold or re-establish normal landing attitude. Add thrust as necessary to control the sink rate. Do not push over, as this may cause a second bounce and possibly damage the nose gear.

Should a high hard bounce occur, initiate an immediate go-around. Apply go-around thrust and use normal go-around procedures. A second touchdown may occur during the go-around. Do not retract the landing gear until a positive rate of climb is established and called by either pilot.

Speedbrake

Speedbrake should be armed to extend automatically. Both pilots should monitor speedbrake extension after touchdown. If automatic extension fails, the Captain should immediately extend them manually.

Note: Unless speedbrake is raised after touchdown, braking effectiveness may be reduced initially by as much as 60%, since very little weight will be on the wheels, and brake application may cause rapid anti-skid modulation.

Caution: To protect as much as possible from a tailstrike during landing, the PF must make certain that the landing attitude does not increase after touchdown.

Rejected Landing

The Rejected Landing procedure prior to touchdown is identical to a go-around:

- Set thrust and select flaps 20 / 5 while rotating to go-around attitude.
- Retract the landing gear only after a positive rate of climb is established and called by either pilot.
- Retract the flaps on the normal flap retraction schedule.

The Rejected Landing procedure after touchdown differs in that the TO/GA switches are inhibited below 2 feet RA on the B777. After touchdown the procedures are:

- Manual go-around (disconnect autopilot).
- Set thrust (push throttles to G/A power manually) and select flaps 20 / 5.
- Rotate to 15 degrees of pitch.
- When airborne (3 seconds after 5 feet RA) engage TO/GA.
- Retract the landing gear only after a positive rate of climb is established and called by either pilot.
- At 1000' AFE re-engage autopilot.
- Retract the flaps on the normal flap retraction schedule.

Speedbrakes will retract and autobrake will disarm as the throttles are advanced for a rejected landing initiated after touchdown.

WARNING: Do not attempt go-around after reverse thrust has been initiated. Five seconds are required for a reverser to stow in the forward thrust position and a possibility exists that a reverser may not stow in the forward thrust position.

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Reverse Thrust

The importance of establishing the desired reverse thrust level as soon as possible after touchdown cannot be overemphasized. Since the autobrake system senses deceleration and modulates brake pressure the proper application of reverse thrust (idle reverse) will result in the most efficient braking for a large portion of the landing roll.

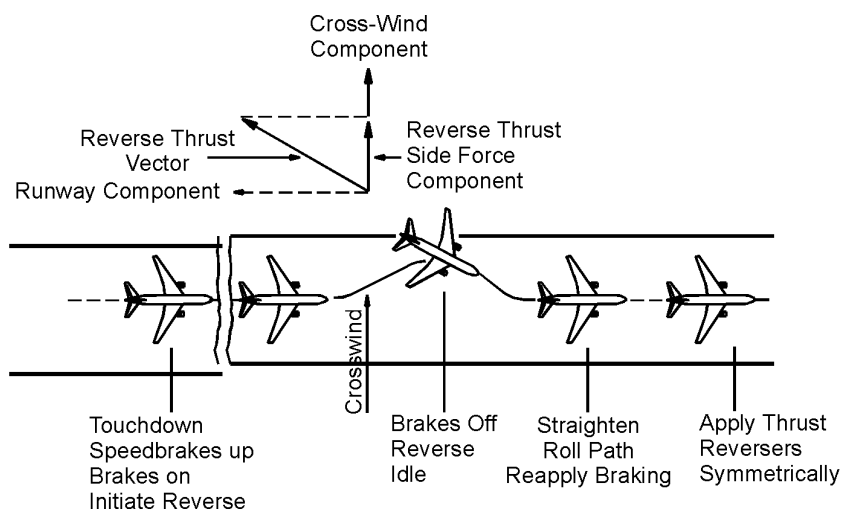
At main gear touchdown, rapidly raise the reverse thrust levers and move them aft to the interlock (idle reverse) position.

Reverse Thrust And Crosswind

The following Figure shows a directional control problem during a landing rollout on a slippery runway with a crosswind. As the aircraft starts to weathervane into the wind, the reverse thrust side force component adds to the crosswind component and drifts the aircraft to the downwind side of the runway.

Main gear tire cornering forces available to counteract this drift will be at a minimum when the anti-skid system is operating at maximum braking effectiveness for existing conditions.

To correct back to the centerline, reduce reverse thrust to reverse idle (if more than idle reverse was used), and release the brakes. This will minimize the reverse thrust side force component without the requirement to go through a full reverser actuation cycle, and improve tire cornering forces for realignment with the runway centerline. Use rudder pedal steering and differential braking, as required, to prevent over correcting past the runway centerline. When re-established near the runway centerline, apply maximum braking and reverse thrust as required to stop the aircraft.



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REVERSE THRUST AND CROSSWIND

Autobrake

As the aircraft decelerates, the autobrake system will decrease braking pressure.

Note: Check that the **AUTOBRAKE** EICAS advisory message is not displayed. If displayed, the autobrake system is disarmed or inoperative.

The aircraft nose will pitch down as the autobrake activate and the nose wheels can be eased onto the runway by small elevator input.

During the landing roll, use manual braking if the deceleration is not suitable for the desired stopping distance.

The autobrake may be released by smoothly applying brake pedal force, as in a normal stop, until the autobrake system disarms. Following disarming of the autobrakes, smoothly release brake pedal pressure and announce “Manual Brakes.”

Disarming the autobrake before coming out of reverse thrust provides a smooth transition to manual braking. Disarm the autobrake by depressing the brake pedals and announce “Manual Brakes.”

The aircraft speed at which the transition from autobrake to manual braking is made varies with aircraft deceleration and stopping requirements. For runway conditions that produce good deceleration, the transition from autobrake to manual brakes should be made at about 60 knots. The transition speed should be closer to a safe taxi speed on very slippery runways or when runway length is limited.

Note: The transition to manual braking should be verbalized by the PF, i.e., “Manual Brakes.” If no call is made, the PM will announce “Manual Brakes.”

Wheel Brakes (Manual)

Note: CAL policy for the B777 is that all landings will be made using autobrake if they are operable.

The pilot's seat and rudder pedals should be adjusted so that it is possible to apply maximum braking with full rudder deflection.

Good pilot technique (a stabilized approach and landing on speed) can increase the safety factor as well as improve total brake / landing maintenance related costs.

During landing, as speed is being reduced, the autobrake system and idle reverse thrust will provide the most economical landing performance.

When landing with manual braking, when runway length requires deceleration at a faster rate, brakes should be applied earlier in the landing roll.

When applying brakes manually, apply a constant brake pedal pressure for the desired deceleration.

It is estimated that manual braking techniques frequently involve a four to five second delay between main gear touchdown and brake pedal application, even when actual conditions reflect the need for a more rapid initiation of braking. This delayed braking can result in the loss of 800' to 1,000' of runway. Directional control requirements for crosswind conditions and low visibility may further increase the above delays, as can the distraction arising from a malfunctioning reverser system.

Note: "Riding" the brakes during taxi causes excessive brake wear.

The anti-skid system will stop the aircraft for all runway conditions in a shorter distance than is possible with either anti-skid off or brake pedal modulation. The anti-skid system adapts pilot-applied brake pressure to runway conditions by sensing an impending skid condition and adjusting the brake pressure to each individual wheel for maximum braking effort. When brakes are applied on a slippery runway, several skid cycles will occur before the anti-skid system establishes the right amount of brake pressure for the most effective braking. If the pilot modulates the brake pedals, the anti-skid system is forced to readjust the brake pressure to establish optimum braking. During this readjustment time, braking efficiency is lost.

Due to the low available braking coefficient of friction on extremely slippery runways at high speeds, the pilot is confronted with a rather gradual buildup of deceleration and may interpret the lack of an abrupt sensation of deceleration as a total anti-skid failure.

Landing Roll Procedure (Summary)

After touchdown and during landing roll, the following procedures are accomplished during normal deceleration.

PILOT FLYING	PILOT MONITORING
Throttles - Idle	
Check speedbrake lever - full up.	Check speedbrake lever - full up.
Fly the nose gear or relax back pressure.	
If autobrake are used and the EICAS advisory AUTOBRAKE displays, or if deceleration is not normal, brake manually.	
Reverse Thrust - Initiate Without delay, raise both reverse thrust levers to the interlock, then to the idle reverse thrust position.	Monitor REV indicating lights displayed on upper EICAS for normal indication (amber - reverser unlocked or in transit, green - reverser deployed). Engine Instruments monitor. Advise PF of any engine limit being approached, exceeded, or any other abnormalities.
At approx. 80 knots, if greater than idle reverse was required gradually reduce reverse thrust to be at idle reverse when reaching taxi speed 60 knots.	Call out "80 KNOTS."
At approximately normal taxi speed, slowly move the reverse thrust levers to the full down position.	Observe REV lights on upper EICAS extinguished.
Release autobrake by applying a light pedal force. PF will Announce "MANUAL BRAKES."	Call "Manual Brakes" if not announced.

WARNING: After reverse thrust has been initiated, a full stop landing must be made.

Note: The Captain will assume control of the aircraft, with engines in idle reverse, not later than when the aircraft leaves the runway centerline. The Captain will announce "I have the aircraft."

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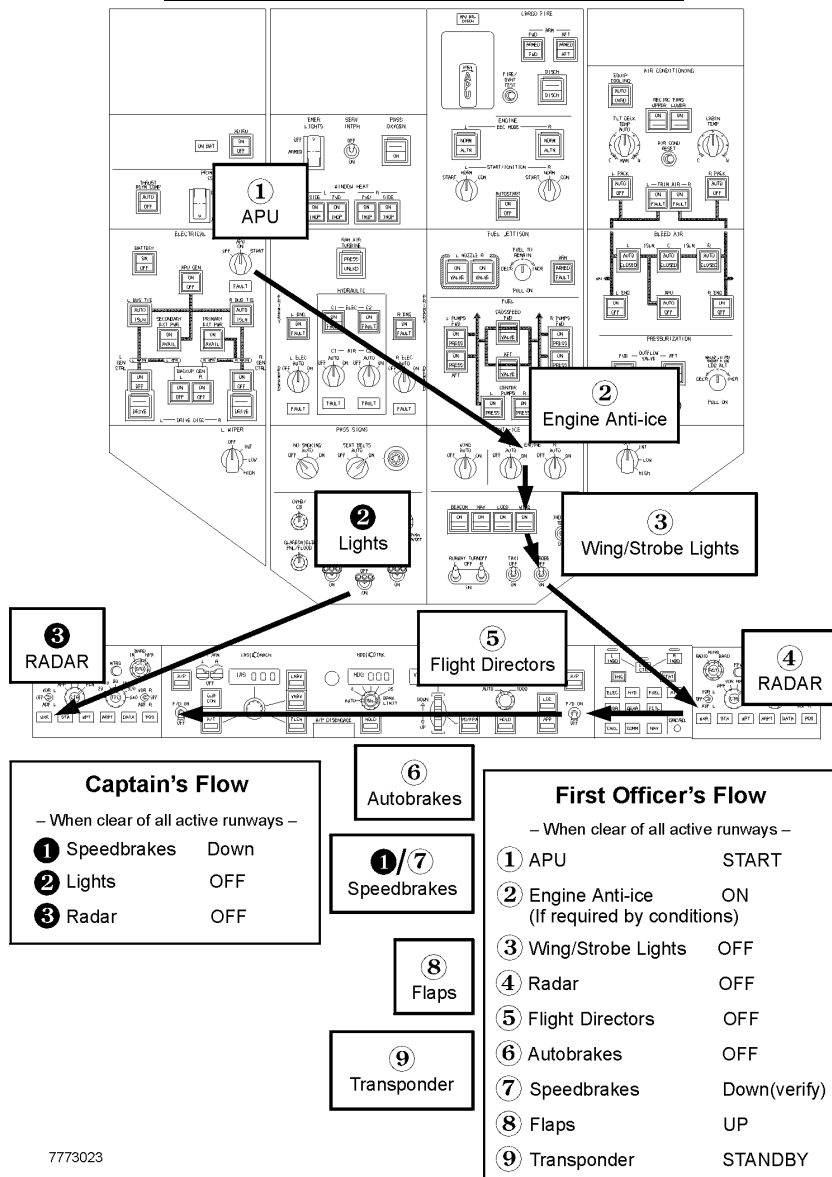
Landing - Summary

In summary, the pilot should check runway conditions prior to approach. The aircraft should be flown before touchdown in a manner that will minimize the total landing distance and use as much of the total runway as possible without risking a “Short” landing. During the approach, the pilot should:

- Arm the autobrake system by selecting desired deceleration level.
- Arm speedbrake.
- Plan for touchdown 1,500’ from the threshold.
- Stay on the recommended glide path.
- Maintain close control over the approach speed to keep it at the speed recommended for existing conditions. Make the necessary corrections for windshear and gust. The majority of long landings and tail scrapes during landings are the result of holding the aircraft off the runway for a smooth touchdown. The aircraft should be flown onto the runway at the desired point even if the speed is high.
- Immediately after touchdown, expeditiously accomplish the landing roll procedure.
- Make certain that aircraft is not allowed to “Pitch Up” after touchdown. Fly the nose down to the runway.
- If the F/O is the PF, the Captain will assume control of the aircraft with the throttles at idle reverse not later than when the aircraft leaves the runway centerline. The Captain will announce “I have the aircraft.”

For detailed discussion of landing procedures on wet or slippery runways, see cold weather operation in this section.

AFTER LANDING FLOW



AFTER LANDING

The AFTER LANDING flow is accomplished by the First Officer only after the checklist has been called for by the Captain.

The Captain will call for the AFTER LANDING checklist when time permits and clear of all active runways. At the Captain's discretion, the checklist may be accomplished if a significant taxi period or hold is encountered after clearing the landing runway and before crossing other active runways.

The First Officer will verify that all items have been accomplished, and will report "AFTER LANDING CHECKLIST COMPLETE." The First Officer will not read the challenges and responses aloud. In the event any individual items are not accomplished, the First Officer will bring those items to the attention of the Captain.

F/O Challenge (Silent)	AFTER LANDING	F/O Response (Silent)
APU		(AS REQUIRED)
Anti-Ice		(AS REQUIRED)
Exterior Lights.....		(AS REQUIRED)
Radar		OFF
Autobrake.....		OFF
Speedbrake.....		DOWN
Flaps		UP
Transponder.....		STANDBY

F/O Challenge (Silent)**F/O Response (Silent)**

APU (AS REQUIRED)

Start the APU if its use for air conditioning or electrical requirements is anticipated.

Anti-Ice (AS REQUIRED)

Wing anti-ice is verified in the AUTO position. Engine anti-ice is turned on if icing conditions exist on the ramp. Refer to the section titled COLD WEATHER OPERATIONS located in this section for further considerations. Window heat is normally left on at through-flight stations.

Exterior Lights..... (AS REQUIRED)

Daylight Leave NAV lights on. F/O turn off Strobe lights.

Darkness Leave NAV and Logo lights on. Turn off Strobe lights.
Use external lighting as necessary for taxi.

Radar OFF

Flight Directors (Flow)..... OFF

Autobrake..... OFF

Speedbrake DOWN

Normally, the Captain will stow the speedbrake handle.

Flaps UP

Flaps will be retracted unless landing/taxiing in snow, ice, or slush. In that case, do not retract beyond Flaps 20 until maintenance inspection of the inboard flap wells confirms no accumulation.

Transponder.....STANDBY

AFTER LANDING NOTES

The AFTER LANDING Checklist must be accomplished prior to engine shutdown, and the required cooling times must be observed.

Engine Cool Down Prior to Shutdown

A one-minute engine cool down period is the absolute minimum time required. If engine reverse above idle is used, a three-minute engine cool down period is required.

GATE ARRIVAL PROCEDURES**Parking Aircraft**

Upon arrival of aircraft at station, the assigned safety man will guide it to the normal parking location.

Parallel Parking

The safety man is responsible to ensure that aircraft, personnel, and equipment at gate behind are safe from injury or damage from jet blast before giving clearance signal for aircraft to taxi into forward gate. The safety man must advise high lift truck operators at immediate gate behind to lower truck bed and hold aircraft out of forward gate until bed on truck has been lowered.

J-Line Parking

The safety man will assume a position at the base of the J-Line, assisting the flight deck in aligning the nose wheel. When the aircraft is signaled to turn, the safety man will assume a position on the left side of the aircraft 45° to the flight deck, and walk the aircraft to its final position.

It is most important that the aircraft continue on a straight line for approximately 10' after the last turn is completed. This ensures that all wheels are in line and that the stress placed on the landing gear is relieved.

Nose-In Parking

Nose-In Without Mechanical Aids - The safety man will provide appropriate signals to the flight deck from a position which affords 100% visibility by the flight deck. The signals will relate solely to wheel alignment and stopping position.

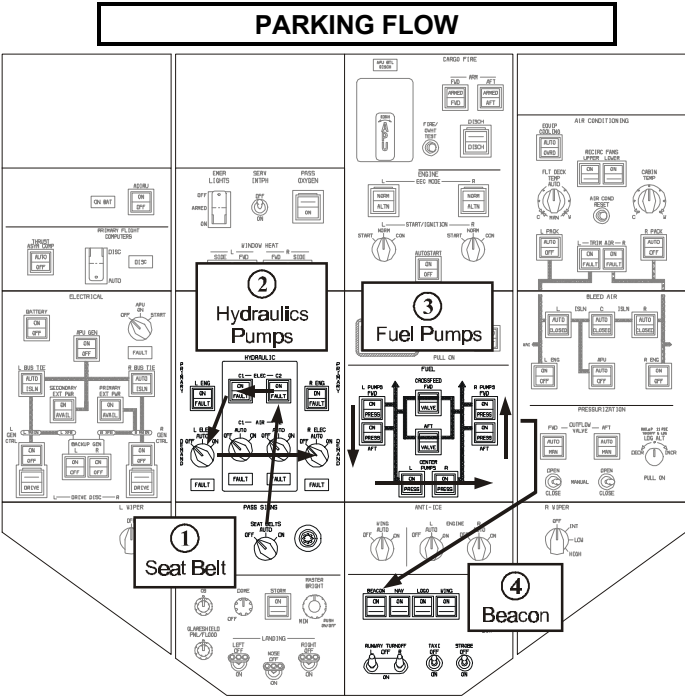
Nose-In With Mechanical Aids - Once ramp clearance has been ascertained by either the ramp supervisor or his/her designated alternate, a visual signal will be activated to advise the flight deck that parking activity may commence. At no time, then, will ground personnel be directly involved in the parking of the aircraft itself.

After the aircraft has come to a complete stop, an agent will insert wheel chocks firmly both fore and aft of either the inboard main wheel assemblies or the nose wheel tires. After the chocks are inserted, a hand signal will be given to the crew to release the brakes.

Brake And Tire Considerations - Quick Turnarounds

Certain combinations of high altitudes, high landing weights, and high temperatures may cause excessive brake and tire heating during the landing. For information on minimum turnaround times consult the charts in Performance Section 5. If the **BRAKE TEMP** advisory message on EICAS is not displayed 10 to 15 minutes after parking, then no waiting period is required.

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Captain's Flow	
1 Fuel Control Switches	CUTOFF
2 Parking Brake	RELEASE

First Officer's Flow	
1 Seat Belts	OFF
2 Hydraulic Pumps	OFF
3 Fuel Pumps	OFF
4 Beacon	OFF

PARKING

The parking procedure is initiated after the aircraft comes to a stop at the gate or parking spot and the Captain has called for the PARKING Checklist.

F/O Challenge	PARKING	Captain Respond
Fuel Control Switches		CUTOFF
Parking Brake.....		(AS REQUIRED)
Seat Belt Sign		OFF
Hydraulic System		SET
Fuel Pumps		OFF
Beacon		OFF
Flight Directors		OFF
Log Book / FOB / ACARS.....		COMPLETED
ADIRU		OFF

F/O Challenge**Captain Respond**

Fuel Control Switches CUTOFF

The Captain will shut down the engine(s) upon arrival in the final park position and after External Power or APU Power is available and selected, as applicable. The Captain will monitor engine instruments to ensure that a complete shutdown has occurred.

Parking Brake.....(AS REQUIRED)

Initially set parking brake when at a full stop. After all engines are shut down and the appropriate signal has been received from ground service personnel that the wheels are chocked, release the parking brake.

Seat Belt Sign OFF

The First Officer will turn the seat belt sign off when he/she observes the parking brake set, unless the Captain requests otherwise.

External Power Switch (Flow)..... PUSH

If required for electrical power, push switch when **PRIMARY OR SECONDARY AVAIL** light illuminated and observe **ON** light/s illuminates.

Hydraulic System SET

Note: Right demand pump selector **MUST** be placed in the OFF position last. Failure to depressurize the right system last **WILL** transfer hydraulic fluid from the center system into the right system causing an overfill (OF).

C2 and C1 PRIMARY pump switches..... OFF

Left, C1 and C2 DEMAND pump selectors OFF

Right DEMAND pump selector OFF

All electric and air driven hydraulic pump switches are turned OFF. Engine pump switches are left ON.

Fuel Pumps OFF

Place all fuel pumps switches OFF. If APU is running and AC busses are powered, left forward fuel pump will be on and **PRESS** light extinguished, regardless of pump switch position.

Engine Anti-Ice (Flow) AUTO

Beacon OFF

Flight Directors OFF

Flight directors should be turned off to assure recycling of the FMA indications for the next departure.

Status Display (Flow) ON

Note: Disregard the EICAS alert and status messages displayed during the two-minute PFC self-test after hydraulic shutdown.

Check for messages affecting dispatch. Record messages in maintenance logbook.

Logbook / FOB / ACARSCOMPLETED

Record inertial monitor data in the logbook as described in the LRN/ETOPS Section 3-1.

Actual FOB will be recorded in the logbook after each leg. Complete the ACARS post-flight report.

ADIRU OFF

Both A/C and D/C electrical systems should remain powered until the ADIRU shut down.

TERMINATION

Note: Normally the flight crew will not depower the aircraft.

The Captain calls for and either pilot can accomplish the following Termination procedure / checklist as a READ AND DO procedure. The TERMINATION Checklist should be completed whenever the aircraft is to be left unattended for a significant period of time, when turning the aircraft over to maintenance or station personnel for an overnight, or when overnighing at a non-maintenance station.

Either Pilot Challenge	TERMINATION	Either Pilot Respond
EMER LIGHTS.....		OFF
Window Heat.....		OFF
Packs		OFF
APU / EXT Power.....		(AS REQUIRED)
Battery Switch.....		(AS REQUIRED)

Either Pilot Challenge**Either Pilot Accomplish**

EMER LIGHTS..... OFF

Do not disarm the **EMER LIGHTS** until all passengers have deplaned.

Window Heat..... OFF

Packs OFF

The APU will continue to run after the switch has been placed to OFF, depending upon how long it has been since it operated with a pneumatic load. Selecting packs OFF when no longer needed for air conditioning reduces the shutdown delay time.

APU/EXT Power(AS REQUIRED)

Configure the electrical system as required. Normally leave the electrical system powered. Use of external power is preferable to operation of the APU. Consideration should be given to depowering the electrical system if the aircraft will be left unattended, as a precaution to prevent depletion of the battery should the external power fail. If overnight at a non-maintenance base, shut down the APU and turn battery switch off. If external power is available, it may be connected and used to power lights in the cabin by selecting the ground service switch at the forward flight attendant station to ON.

At the request of maintenance or station personnel, the APU may be left running and the electrical system fully powered.

Battery Switch.....(AS REQUIRED)

When the **APU COOLDOWN** EICAS memo message extinguishes turn the battery switch OFF unless APU operation or DC power is required by the circumstances.

OVERNIGHT PARKING AT NON-MAINTENANCE STATION

Procedures for overnighting an aircraft at a non-maintenance station are as follows:

- When the flight crew is aware that a non-maintenance station will be used to overnight the aircraft, the last maintenance station that is passed through should be notified of any condition or fault that may affect the following morning's departure.
- Upon termination of a flight at a non-maintenance station, the flight crew must contact Maintenance Control and advise them of any maintenance problems of a serious nature or if servicing is required. A serious problem is defined as one that would ground the aircraft or cause it to be in violation of the minimum equipment list (MEL) or configuration deviation list (CDL).
- If high winds are forecast, park aircraft into wind or forecast wind. Inform Maintenance Control of existing fuel load in the event ballast fuel is necessary.
- Prior to leaving the aircraft, a walk-around inspection should be conducted by one of the crewmembers.
- Terminal operations should provide additional securing of the aircraft, which includes at least closing all the doors and installing chocks.

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TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM

TCAS II is installed and interfaced with the aircraft's transponder and PFD's to provide the flight crew with graphic air traffic displays as a backup to visual collision avoidance, application of right of way rules, and Air Traffic Control (ATC).

To effectively work, timely and reliable crew response to TCAS advisories is essential. Delayed crew response or reluctance of a flight crew to adjust flight path as advised by TCAS due to ATC clearance provisions, fear of later FAA scrutiny, or other factors could significantly decrease or negate the protection afforded by TCAS. Operation of the system is expected to be in accordance with the following:

General

Unless otherwise specified, pilots are expected to operate TCAS while in flight in all airspace, including oceanic, international, and foreign airspace. TCAS operation should be in the TA/RA mode, except as otherwise required.

During climb or descent, ABOVE or BELOW may be selected to clear the airspace into which the aircraft is climbing or descending. This action affects only the display of traffic and does not effect the TA/RA.

Deviation From Assigned Clearance

Deviation from a clearance in response to a TA only is not authorized unless the traffic is acquired visually, and the pilots determine that evasive action is required in accordance with normal see and avoid practices. Such evasive action will be reported as due to visual contact with the traffic.

Deviation from a clearance in response to an RA is authorized only to the extent required to follow the RA display guidance. If the RA requires maneuvering contrary to right of way rules, cloud clearance rules, or other criteria, pilots are expected to follow the TCAS RA guidance. Deviation from rules, policies, procedures, or limitations should be kept to the minimum necessary to comply with TCAS guidance.

Pilot Response To Traffic Alerts (TA)

The flight crew should respond immediately to TA's by attempting to establish visual contact with the traffic. Continue to clear for other traffic during the search for the alert traffic. If the traffic is acquired visually, continue to maintain or attain safe separation in accordance with current FAR's and good operating practices. Do not alter the aircraft's flight path based solely on a TA without visual confirmation of the need to do so. Maneuvering based solely on a TA, in an effort to preempt an RA, is not authorized.

Note: Early TCAS installations were subject to significantly more unnecessary TA's than those equipped with software installed after March of 1992.

Pilot Response To A Resolution Advisory (RA)

The TCAS software design is such that the triggering of an RA indicates a real threat of collision. Therefore, an immediate and correct response to an RA is mandatory unless overriding safety concerns exist. Correct response to an RA is indicated even if the crew believes they have the traffic in sight, due to the possibility of misidentification of the target traffic.

Caution: Once an RA has been issued, safe separation could be compromised if current vertical speed is changed, except as necessary to comply with the RA. This is because TCAS II - to - TCAS II coordination may be in progress with the intruder aircraft, and any change in vertical speed that does not comply with the RA may negate the effectiveness of the other aircraft's compliance with the RA.

Note: The consequences of not following an RA may result in additional RAs in which aural alert and visual annunciations may not agree with each other.

Respond to a preventative RA by monitoring aircraft pitch attitude to ensure that it does not enter the red area. Maneuvering is required if any portion of the aircraft symbol is within the red region on the PFD. Normally, compliance with preventative RA's can be accomplished without deviation from the assigned clearance; however, if deviation is required, it is authorized. All crewmembers should attempt to acquire the traffic visually.

Respond immediately to corrective RA's by altering the aircraft's pitch attitude and flight path as indicated. If maneuvering is required, disengage the autopilot and autothrottle and smoothly adjust pitch and thrust to satisfy RA commands. The pitch must be adjusted to fly the aircraft symbol just out of the red region(s) on the PFD or to achieve a vertical speed just outside the red band(s) on the RA VSI. Adjust thrust, as required, to maintain desired airspeed. Attempt to establish visual contact.

If a climb RA occurs in the landing configuration:

- Disengage autopilot and autothrottle and advance thrust levers to maximum thrust.
- Smoothly adjust pitch to satisfy RA commands while performing normal go-around procedures.
- Attempt to establish visual contact.
- When clear of conflict, coordinate with ATC for further clearance.

The pilot flying should dedicate his/her direct attention to accurately flying the aircraft in accordance with the RA commands. Respond immediately and decisively to increase, decrease, and reversal commands. Initial response delayed over 5 seconds, or response to subsequent modified (Increase or Reversal) guidance delayed over 2 1/2 seconds, will compromise separation. Properly executed, the RA maneuver is mild and does not require large or abrupt control movements. RA maneuvers require only small pitch attitude changes. Remember that the passengers and flight attendants may not all be seated during this maneuver. When complying with an RA, flight director commands may be followed only if they result in a vertical speed that satisfies the RA command.

Pilots should maintain situational awareness since TCAS may issue RA's in conflict with terrain considerations, such as during approaches into rising terrain or during an obstacle limited climb. Continue to follow the planned lateral flight path unless visual contact with the conflicting traffic requires other action. Windshear, GPWS, and stall warnings take precedence over TCAS advisories. Stick shaker must be respected at all times. Complying with RA's may result in brief exceedance of altitude and/or placard limits. Smoothly and expeditiously return to appropriate altitudes and speeds when clear of conflict. Maneuvering opposite to an RA command is not recommended since TCAS may be coordinating maneuvers with other aircraft.

The other crewmember(s), as well as any flight deck observers, should attempt to obtain visual contact with the traffic if possible.

Caution: Turns are not authorized to avoid traffic unless the traffic has been visually acquired and positively identified.

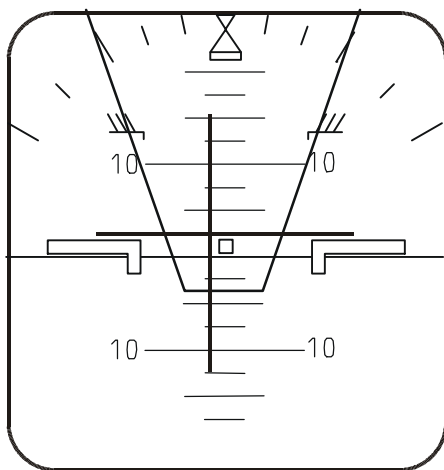
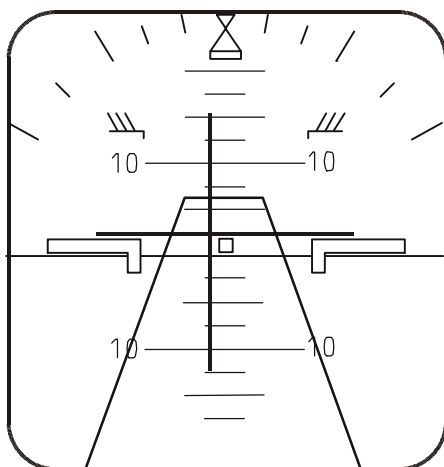
Respond to an RA as specified by the warning. TCAS does not track just one target, but monitors the airspace around the aircraft. When it issues an RA, it has taken all surrounding Mode S or Mode C traffic into account. Excessive maneuvering is not appropriate or advisable, and only tends to increase the possibility of interference with other traffic, needlessly exaggerates any ATC clearance deviation, and nullifies TCAS-to-TCAS maneuver coordination. From level flight, proper response to an RA typically results in an overall altitude deviation of 600' or less. A Climb or Descend RA requires that a vertical speed of 1500 fpm be established and maintained. The use of vertical rates in excess of 1500 fpm is neither required nor desirable due to the possibility of large altitude deviations. There is no situation that requires a climb or descent to the next higher or lower cruising altitude or flight level. Be alert for a downgrade of the RA indication, and begin to reduce deviations as soon as possible. Attempt to comply with as much of the current clearance as possible during the RA. For example, continue to fly the ground path specified in the current clearance, if possible, while altering the vertical path in response to the RA. Promptly and smoothly return to the current ATC clearance when the TCAS message, "CLEAR OF CONFLICT," is heard.

ATC Considerations

WARNING: Do not accept a controller instruction to disregard a TCAS RA.

In responding to a TCAS RA that directs a deviation in assigned altitude, communication with the controlling ATC facility is required as soon as practicable after responding to the RA. Turns to avoid traffic are never TCAS initiated. Therefore, if a turn is made, it must be done based on conventional see and avoid practices, after the traffic is acquired visually. The turn should be reported to the controller as being a result of the pilot's visual evaluation of the situation.

Controllers have a much more complete view of the air traffic situation than TCAS allows. Try to refrain from second guessing ATC or asking for special handling based on the potentially incomplete traffic information available on the TCAS display.

**PFD****TCAS PITCH COMMAND**

Operation In TA ONLY Mode

When operating in the TA ONLY mode, a TCAS-equipped aircraft will appear to another TCAS aircraft as Mode C Only. In addition to inhibiting RA's in the TA only flight deck, TCAS-to-TCAS coordination does not occur. These issues, along with the fact that few general aviation aircraft are TCAS equipped, mandate that use of the TA (only) mode be limited to situations of operational necessity. Use of TA (only) may be indicated in one or more of the following circumstances:

- During takeoff towards known nearby traffic which is in positive visual contact and which would cause an unwanted RA. Reselect TA/RA as soon as possible.
- During parallel approaches when the other aircraft has been positively identified visually (VMC) or by the controller (IMC).
- In visual conditions when flying in known close proximity to other aircraft.
- During emergencies and in-flight failures that severely limit aircraft performance or control to the point that ability to respond to an RA is in doubt.
- In response to specific Company guidance regarding areas or operations identified as having a verified and significant potential for unwarranted RA's.

Operational Limitations

TCAS does not alter or diminish the pilot's basic authority and responsibility to ensure safe flight. Since TCAS does not respond to aircraft, which are not transponder equipped, or aircraft with a transponder failure, TCAS alone does not ensure safe separation in every case. Other aircraft may not be able to maneuver due to equipment malfunctions. Further, TCAS RA's may, in some cases, conflict with flight path requirements due to terrain, such as an obstacle limited climb segment or an approach to rising terrain. Since many approved instrument procedures and IFR clearances are predicated on avoiding high terrain or obstacles, it is particularly important that pilots maintain situational awareness and continue to use good operating practices and judgment when following TCAS RA's. TCAS does not diminish the flight crew's responsibility for outside visual scan and see and avoid vigilance.

TCAS may occasionally issue an RA against an aircraft that has legal separation. This may be the result of one aircraft maneuvering, or in the case of 500' VFR - IFR separation, due to either or both aircraft being only slightly off altitude. TCAS uses a target's existing and previous vertical speed to predict separation. It is not aware of traffic's intention to level off at an altitude above or below its own altitude. For this reason, an RA can be issued prior to such a level off.

TCAS is only required to track aircraft within 14 miles; outside of this range, targets may be intermittent. Non-transponder or inoperative transponder aircraft are invisible to TCAS. Traffic with a transponder, but without altitude reporting, will not generate an RA. Mode C only transponders are not capable of coordinating responses. The TCAS aircraft assumes that the Mode C aircraft will not change its flight path.

Required Reports

Submit a Captain's Irregularity Report whenever response to an RA requires deviation from an assigned clearance. Submit Aviation Safety Reporting System (ASRS) reports at the crew's discretion. Report areas or operations that result in a high number of TA's or unwarranted RA's via Captain Information Report to the Chief Pilot's Office.

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GROUND PROXIMITY WARNING SYSTEM

The GPWS contains all of the standard terrain / configuration warnings and alerts in addition to a look – ahead terrain warning feature (see Section 6.15 for System Description).

Flight crew required responses to warnings / alerts are stated below.

“TERRAIN”/“PULL UP”/Configuration Warning

- Aggressively advance throttles to mechanical stops to ensure maximum thrust is obtained with minimum delay.
- Disengage the autopilot and autothrottles.
- Rotate aggressively initially toward a 20° pitch attitude. Disregard flight director indications. Stop rotation immediately if stick shaker or buffet should occur (do not pitch above pitch limit indicator [PLI]). Roll wings level if in a turn to provide maximum lifting force.
- Verify speedbrakes are retracted.
- Climb at the best angle of climb until clear of terrain.

WARNING: Any “TERRAIN,” “PULL UP,” or configuration warning that occurs or continues **below 500’ AFE** mandates a go-around, regardless of flight conditions.

Note: If a warning occurs **above 500’ AFE** when flying under daylight VMC conditions, and positive visual verification is made that no hazard exists and that aircraft configuration is correct, the warning may be regarded as cautionary and the approach may be continued.

GPWS Alert

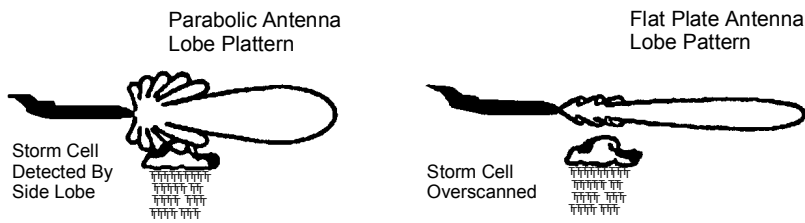
GPWS alerts of “DON’T SINK,” “SINK RATE,” “GLIDE SLOPE,” or “BANK ANGLE” require immediate response by the flight crew. The PF must take immediate action to correct the flight path.

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ADVERSE WEATHER**WEATHER RADAR**

The requirements for weather radar for dispatch are stated in the aircraft minimum equipment list. If the radar becomes inoperative in flight, the flight may not enter a known or forecast thunderstorm area unless the Captain is satisfied that thunderstorms can be avoided visually. If already in a thunderstorm area when the radar becomes inoperative, the flight will avoid thunderstorms visually, or if this is impossible, slow to recommended turbulence penetration speed and take the shortest course out of the area consistent with safety.

Continental aircraft are equipped with an X-Band weather radar receiver/transmitter and a flat-plate antenna. The flat-plate antenna produces a narrow beam (3.0°) without any significant sidelobes. For optimum performance, more tilt adjustment will be required than with the older parabolic type antenna which produce numerous sidelobes, as shown in the diagram below.



Resolution

There are several factors which affect the resolution of the radar system.

Range

Increasing range will decrease the radar return. The system compensates for this by varying the system gain with range, therefore giving as accurate a return as possible, at varying ranges.

Attenuation

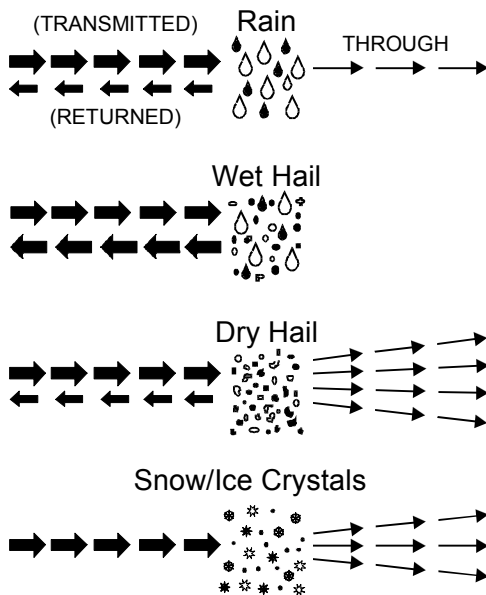
Intervening precipitation and increasing range tend to attenuate the beam. The radar compensates for precipitation or range attenuation, so that the correct color is displayed on the indicator. This feature, called penetration compensation, allows more accurate presentation of storm cells even when viewed through intervening rainfall.

Caution: Although this special circuitry compensates for areas of precipitation, weather radar should not be used for penetration of thunderstorm areas where the precipitation between aircraft and target is moderate to heavy.

The storm behind the storm may not be displayed under extreme attenuation conditions. Do not penetrate strong targets assuming there is nothing behind them. If the ground cannot be painted behind the storm, then the attenuation compensation is not effective due to extremely high attenuation.

Nature Of Target

Storm targets differ in their ability to return a signal. Precipitation tends to absorb part of the transmitted signal which masks targets behind heavy precipitation areas.



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As the tilt control is used to sweep a storm target, the return may change color, not due to a change in precipitation rate, but to the type of precipitation target encountered.

Gain Control

The 12 o'clock detent of the GAIN knob is auto gain. This is the normal position. Manual gain control is available in all modes by moving the GAIN knob left or right of the 12 o'clock position (see Sect 6.15, Warn Systems, for a complete description).

Manual gain should only be used to reduce the receiver's sensitivity to aid in determining the relative intensity of multiple thunderstorms and embedded cells.

Caution: Maximum manual gain settings will enhance radar receiver sensitivity, but as the gain is reduced there is a chance that all radar displays will be eliminated.

Turbulence

Selecting the TURB position causes all weather targets (precipitation and turbulence) to be displayed. Turbulence detection is limited to the first 40 NM regardless of the range selected. It will be displayed in magenta on the indicator superimposed over the weather information. This feature allows the detection of storm related turbulence by measuring the Doppler shift of detected particles. Precipitation must be present for this mode to operate. Clear air turbulence (CAT) will not be detected. Manual gain is available in TURB mode, but should have no effect on turbulence targets.

Selecting the wx position will cause all precipitation targets to be displayed. Detectable weather will be displayed in three colors; red, yellow, and green.

Inflight Operations

Antenna Tilt Operations

Takeoff and Landings

Operations below 10,000' usually require a tilt setting of 2° - 3° upward tilt. This will provide target detection up to 40 NM, without excessive ground returns, and eliminate frequent tilt adjustment. The tilt setting should be adjusted as necessary to optimize target display. A solid ground return between 35 to 40 NM ensures targets within 35 NM will be detected. If tilt settings below 4 degrees are used for takeoff, some ground return will be detected until passing 5,000' AGL. This is due to minor sidelobes. Set 7° up initially for takeoff.

Middle Altitudes (near 20,000')

Antenna tilt settings should be roughly 0° or slightly down. For over-land operation, adjust tilt control until a small arc of ground return appears at the outer edge of the display. Storm cells displayed between half scale and the outer edge of the display should be monitored; tilt the antenna down and alternating range setting as necessary to avoid over-scanning as you approach these cells.

Higher Altitude (around 35,000')

At longer ranges it will be difficult to obtain ground targets at the outermost area of the display due to the curvature of the earth. Overwater, or if ground returns cannot be obtained at outer edge, use the following cruise tilt angles:

<u>Target Range (NM)</u>	<u>Approximate Tilt Angle (Degrees)</u>	
	<u>Over Land</u>	<u>Over Water</u>
160	2 Down	3 Down
80	3 Down	5 Down
40	5 Down	8 Down

As targets move past the half-way position, adjust antenna tilt angle and range setting as necessary to avoid over-scanning. Detection of targets closer than 20 NM may be difficult, as the large tilt-down settings being used may result in excessive ground clutter and/or more distant storms not being detected.

Storm Height

Most formulas and charts used to determine storm heights are complex as a result of the accuracy of calibration and the curvature of the earth. However, the following is a method that estimates the top of the detectable moisture (radar top), and is independent of calibration and curvature problems.

While scanning for storm targets, the most effective tilt angle of the antenna depends upon the altitude of the aircraft and the selected range. Once a storm is detected by varying the tilt angle (see previous table), decrease the tilt until the ground return touches the center of the storm and note the tilt angle displayed on the radar indicator. Now increase the tilt until the storm disappears and again note the tilt angle. The difference of these two settings is important, and eliminates the need of calibration corrections. Multiplying this tilt difference figure times the distance of the storm from the aircraft equals the storm height above ground level (i.e., a five degree difference of a storm at fifty miles equals a storm height of 250 or 25,000 ft. AGL).

Recall, the radar top is only the top of the moisture return and not the top of the cloud. Experience has shown that an additional 10,000' to 15,000' must be added to the radar top to ensure total clearance of the storm area.

Overwater Operating Procedures

- Do not use MAP mode for weather detection.
- Limit the use of 320 NM range to MAP mode. Weather detection is marginal beyond 220 NM.
- Use 160 NM range for weather surveillance with tilt down 3° and expect some sea clutter at the outer limits (i.e., above 120 NM).
- As weather is detected, range down to 80 NM then 40 NM using tilt to determine the radar tops. Radar tops should be avoided by approximately 10,000' to 15,000'. Circumnavigate if required.
- Periodically return to 160 NM to re-examine the big picture.

ENGINE OPERATION DURING SEVERE PRECIPITATION

Flights should be conducted to avoid moderate to severe thunderstorm activity by overflight or circumnavigation. To the maximum extent possible, moderate to heavy rain / hail should also be avoided. Weather radar, pilot reports, and flight crew observations may be used by the flight crew to determine when moderate to heavy rain / hail / sleet will be encountered or unavoidable.

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WINDSHEAR AVOIDANCE AND RECOVERY

General

The first and foremost rule is to avoid windshear. As enhanced detection and guidance capabilities become available, the pilot must not perceive these aids as providing the capability to penetrate windshear. These aids are intended to be used for avoidance only, in the same manner as radar is used as an aid in avoiding thunderstorms.

Microburst Windshear Probability Guidelines

Observation

Probability Of Windshear

Presence Of Convective Weather Near Intended Flight Path

- With Localized Strong Winds (tower report or observed blowing dust, rings of dust, tornado-line features, etc.).....HIGH
- With Heavy Precipitation (observed or radar indications of contour, red or attenuation shadow)HIGH
- With RainshowerMEDIUM
- With LightningMEDIUM
- With VirgaMEDIUM
- With Moderate Or Greater Turbulence
(reported or with radar indications)MEDIUM
- With Temperature/Dew Point Spread Between
30 And 50 Degrees FahrenheitMEDIUM
- Onboard Windshear Detection System Alert
(reported or observed).....HIGH

Pirep Of Airspeed Loss Or Gain

- 20 Knots Or GreaterHIGH
- Less Than 20 KnotsMEDIUM

LLWAS Alert / Wind Velocity Change

- 20 Knots Or GreaterHIGH
- Less Than 20 KnotsMEDIUM
- Forecast Of Convective Weather LOW

Note: These guidelines apply to operations in the vicinity (within 3 miles of the point of takeoff or landing along the intended flight path below 1000' AGL). The clues should be considered cumulative. If more than one is observed, the probability is increased. The hazard increases with proximity to the convective weather. Weather assessments should be made continuously.

The windshear recovery enhancement system includes, a prediction, a detection and a guidance system. Each system operates independently of the other.

Predictive Windshear System (PWS)

The Predictive Windshear System (PWS) is part of the weather radar system. It augments the GPWS windshear detection system. The PWS uses radar imaging to detect disturbed air prior to entering a windshear. Aural and visual alerts warn the crew of windshear. The PWS is activated by the following methods:

- Manually on the ground when the weather radar is activated with the EFIS control panel WXR switch
- Automatically on the ground when the thrust levers are set for takeoff
- Automatically in the air when below 2300' RA.

There are two alerts associated with the PWS: A warning alert and a caution alert. These alerts are available below 1200' RA.

A PWS caution windshear alert is activated if a windshear is detected between 0.5 NM and 3 NM and 25 degrees left or right of the aircraft's magnetic heading, and not within the warning alert area.

On the ground, a PWS warning alert is activated if a windshear is detected between 0.5 NM and 3 NM and 0.25 NM right or left of the aircraft's magnetic heading.

In the air, a PWS warning alert is activated if a windshear is detected between 0.5 NM and 1.5 NM and 0.25 NM left or right of the aircraft's magnetic heading.

PWS windshear alerts are prioritized along with GPWS and TCAS alerts based on the level of the hazard and time required for flight crews to react.

Predictive Windshear Annunciation's

AURAL ALERT	VISUAL ALERT	DESCRIPTION
"MONITOR RADAR DISPLAY"	Red & Black windshear symbol on ND (in expanded MAP, center MAP, and expanded VOR or APP modes only). Amber WINDSHEAR on ND (all modes).	Caution alert. Windshear symbol on ND shows windshear position.
"WINDSHEAR AHEAD"	Master WARNING lights Red WINDSHEAR on PFD. Red & Black windshear symbol on ND (in expanded MAP, center MAP, and expanded VOR or APP modes only). Red WINDSHEAR on ND (all modes).	Warning alert (takeoff). Windshear symbol on ND shows windshear position..
"GO AROUND, WINDSHEAR AHEAD"	Master WARNING lights. Red WINDSHEAR on PFD. Red & Black windshear symbol on ND (in expanded MAP, center MAP, and expanded VOR or APP modes only). Red WINDSHEAR on ND (all modes).	Warning alert (approach). Windshear symbol on ND shows windshear position..

GPWS Windshear System (Reactive)

A windshear condition is detected using inputs from aircraft systems including angle of attack (AOA), ADIRU, and Air Data Modules. The minimum windshear intensity which activates a warning is dependent upon flap position, radio altitude, and phase of flight (takeoff or approach). The windshear alert does not annunciate shears of the type which require only routine piloting effort. As a result, the alerting signal is considered a warning level, and specific crew actions are expected.

The GPWS provides the aural and visual alerting signals for windshear conditions. The aural warning consists of a two-tone siren followed by the words "WINDSHEAR, WINDSHEAR, WINDSHEAR." The warning is activated only once during a windshear encounter. The visual warning is provided by illumination of the time critical **WINDSHEAR** annunciation on the Captain's and First Officer's PFD. The lights remain illuminated until a safe airspeed has been re-established after the windshear has dissipated. The windshear warnings take priority over all other GPWS modes.

On takeoff, the alert is enabled at rotation, and remains enabled up to 1500' radio altitude.

On approach, the alert is enabled at 1500' RA and remains enabled until touchdown.

The GPWS windshear warning is the highest level, followed by terrain warnings, predictive windshear, and TCAS.

Reactive Windshear Annunciation's

AURAL ALERT	VISUAL ALERT	DESCRIPTION
Two tone siren followed by: "WINDSHEAR, WINDSHEAR, WINDSHEAR"	Master WARNING lights. Red WINDSHEAR on PFD.	Windshear condition is detected.

Predictive Windshear Procedures

The following procedural chart applies to the predictive windshear system. Continental's policy is to avoid all windshear and other hazardous weather.

Note: During takeoff and landing, the PWS inhibits new caution alerts between 80 knots and 400' RA, and new warning alerts between 100 knots and 50' RA. These inhibits do not remove caution or warning alerts that already exist.

PHASE OF OPERATION	WARNING ALERT	CAUTION ALERT	SYSTEM FAILURE
Before Takeoff	Advise ATC of the location of the Warning Alert. Delay takeoff until the warning is no longer present.	Advise ATC of the location of the Caution Alert. At the Captain's discretion, delay the takeoff or takeoff and maneuver to avoid the hazard.	If predictive windshear system is inoperative, use standard windshear avoidance procedures.
Takeoff Prior to 100 Kts.	Reject the takeoff. Advise ATC of the location of the windshear hazard.	Assure maximum rated thrust is applied. Continue the takeoff, and advise ATC of the hazard and maneuver around the hazard.	If predictive windshear system is inoperative, use standard windshear avoidance procedures.
80 Kts. To 400' RA		New Caution Alerts inhibited.	If predictive windshear system is inoperative, use standard windshear avoidance procedures.
100 Kts. To 50' RA	New Warning Alerts inhibited.		If predictive windshear system is inoperative, use standard windshear avoidance procedures.
After Takeoff	Assure maximum rated thrust is applied. If the windshear is penetrated, utilize windshear recovery procedures. Advise ATC of the hazard.	Assure maximum rated thrust is applied. If the windshear is penetrated, utilize windshear recovery procedures. Advise ATC of the hazard.	If predictive windshear system is inoperative, use standard windshear avoidance procedures.
During Approach	Initiate a normal go-around. If the windshear hazard is penetrated, utilize windshear recovery procedures. Advise ATC of the hazard.	At the Captain's discretion, maneuver around the windshear hazard if a safe stabilized approach can be continued after the maneuver, or initiate a normal go-around. Advise ATC of the hazard.	If predictive windshear system is inoperative, use standard windshear avoidance procedures.

Reactive Windshear Procedures

The Flight Director was chosen as the guidance system because it is simple, displayed on the PFD, and pilots use it on a routine basis. The AFDS provides windshear recovery guidance by means of the normal go-around pitch and roll modes. Go-around is engaged by pushing a TO/GA switch. The control inputs for the guidance come from vertical speed, airspeed and angle of attack. The command guidance control laws are:

The AFDS commands a pitch-up of 15° or slightly below the pitch limit, whichever is lower.

As rate of climb increases, the AFDS transitions from pitch to airspeed control. The target airspeed is the IAS/MACH window airspeed or current airspeed, whichever is greater when TO/GA is engaged. If current airspeed remains above the selected speed for 5 seconds, the selected airspeed is reset to current airspeed, (to a maximum of the IAS/MACH window speed plus 25 knots).

If the autopilot is not engaged when go-around is initiated, the pilot must fly the windshear recovery following the flight director commands. If the autothrottle is not armed, the thrust levers must be advanced manually.

When the aircraft departs the windshear environment, the Flight Director will smoothly transition back to the normal TO/GA mode.

Takeoff

The AFDS provides windshear recovery guidance by means of the normal takeoff pitch and roll modes (TO/GA). The flight director commands a pitch of 15° or slightly below the Pitch Limit Indicator (PLI), whichever is lower.

Operational Precautions

Takeoff

Airports Without Terminal Doppler Weather Radar:

If the preceding conditions exist and PIREPS indicate a windshear in excess of 15 knots with increasing intensity, delay departure 30 minutes.

If the preceding conditions exist and PIREPS indicate a windshear of less than 15 knots with diminishing intensity, delay departure 15 minutes.

Airports With Terminal Doppler Weather Radar:

A Microburst Alert or Windshear Alert will be issued by the tower in conjunction with a clearance to a specific runway. If the clearance does not contain an alert, the flight crew may assume that no alert exists at the present time.

If a Windshear Alert accompanied by a reported gain of airspeed is issued, the crew may take off, but be alert for sudden airspeed increase. If airborne, the pilot should adjust pitch attitude smoothly to maintain desired airspeed, but should not chase large rapid airspeed fluctuations.

If a Windshear Alert accompanied by a reported loss of airspeed, or a Microburst Alert is received, a takeoff should not be attempted. If either alert is received during takeoff prior to 100 knots, the takeoff should be aborted. If either alert is received after 100 knots, the takeoff may be aborted or continued at Captain's discretion after considering runway available, gross weight, and related meteorological conditions.

If, after careful consideration, the decision to continue the takeoff is made:

1. If practical, use the longest suitable runway provided it is clear of areas of known windshear. Use a takeoff flap setting of 20 unless limited by obstacle clearance and/or climb gradient. This setting provides the best performance for countering windshears.
2. Maximum rated takeoff thrust must be used. (Reduced Thrust takeoff is prohibited.)
3. Use the Flight Director display.
4. Use Autothrottles for takeoff.
5. Use increased airspeed at rotation when available. To compute the increased rotation airspeed:
 - Determine the V_1 , V_R , and V_2 speed for the actual aircraft gross weight and flap setting. Set airspeed bugs to these values in the normal manner.
 - Determine the field length limit (runway limit) maximum weight and corresponding V_R for the selected runway.
 - If the field length limit V_R is greater than the actual gross weight V_R (almost always the case), use the higher V_R (up to 20 knots in excess of actual gross weight V_R) for takeoff. Airspeed bugs should NOT be reset to the higher speeds.

- Rotate to normal initial climb attitude at the increased V_R , and maintain this attitude. This technique produces a higher initial climb speed which slowly bleeds off to the normal climb speed.

WARNING: If windshear is encountered at or above the actual gross weight V_R , do not attempt to accelerate to the increased V_R , but rotate without hesitation. If windshear is encountered at or near the actual gross weight V_R and airspeed suddenly decreases, there may not be sufficient runway left to accelerate back to normal V_R . If there is insufficient runway left to stop, initiate a normal rotation at least 2,000' before the end of the runway, even if airspeed is low. Higher than normal attitudes may be required to lift off in the remaining runway. Aft body contact may occur.

Throttles may be advanced to the mechanical stops. If increased airspeed was not used prior to liftoff, accelerating to higher than normal airspeed after liftoff is not recommended. Reducing pitch attitude at low altitude to accelerate might produce a hazard if windshear is encountered.

Once the takeoff is initiated, the flight crew should be alert for airspeed fluctuations. If significant airspeed variations occur below V_1 , the takeoff should be aborted if sufficient runway remains.

Caution: Accelerate / Stop distances are computed assuming a normal acceleration to V_1 . Airspeed fluctuations may cause the aircraft to achieve V_1 at a point farther down the runway than anticipated. Therefore, the aircraft may not be able to stop on the runway.

Approach

Due to configuration and power settings, aircraft are the most vulnerable to windshear effects during the approach and landing phase of flight. Airspeed losses and excessive sink rates should be immediately responded to by the flight crew, since the aircraft may not be able to recover from a situation that has been allowed to progress unchecked. A stabilized approach should be established no later than 1,000' AGL to improve windshear recognition capability.

Select flaps 30. Leave the autopilot and autothrottles engaged and set the normal target value. During the approach, the pilots should continuously monitor airspeed loss reports from other aircraft ahead, or from the tower if equipped with Terminal Doppler Weather Radar. If the autothrottles are disengaged, or planned to be disengaged before landing, the reported airspeed loss should be added to V_{REF} . If this value is in excess of Target airspeed, the pilot should increase to and maintain this speed. The Target bug should remain set based on the surface wind additive only. If the reported airspeed loss, when added to V_{REF} , results in a speed less than Target airspeed, maintain Target airspeed. If the additive to V_{REF} (due to either surface wind or reported loss) results in an adjustment in excess of $V_{REF} + 20$ knots, the approach should not be continued.

Airspeed additive (with autothrottles disengaged) due to reported airspeed loss should be maintained to touchdown; however, the aircraft should not be allowed to “float” beyond the touchdown zone.

WARNING: Increased touchdown speeds increase stopping distance. An additional 20 knots at touchdown can increase stopping distance by as much as 25%.

Vertical speed should be closely monitored. If the descent rate required to maintain the glide path is significantly different than expected (based on ground speed and descent slope) continuance of the approach may not be a safe course of action.

Caution: At airports equipped with Terminal Doppler Weather Radar, a missed approach should be executed if the Microburst Alert or a Windshear Alert, accompanied by a reported airspeed loss of greater than 20 knots, is received.

An increase in airspeed and ballooning above the glideslope may be first indications of a windshear. Do not make large thrust reductions. This increase in performance may be followed soon by a rapid airspeed loss and an additional loss of performance due to a downdraft. The pilot may choose to accept this initial airspeed gain, anticipating an equal or greater loss.

Recovery Maneuver

The following actions are recommended whenever flight path control becomes marginal below 1000' AGL on takeoff or approach. As guidelines, marginal flight path control may be indicated by deviations from target conditions in excess of:

- ± 15 knots indicated airspeed.
- ± 500 FPM vertical speed deviation from normal.
- $\pm 5^\circ$ pitch attitude change.
- ± 1 dot glideslope displacement.
- Unusual throttle position for a significant period of time.

Exact parameters cannot be established. In certain situations where significant rates of change occur, it may be necessary to go-around before any of the above are exceeded. The determination to begin the recovery procedure is subjective and based on the pilot's judgment of the situation.

If flight path control becomes marginal at low altitude, initiate the windshear recovery maneuver without delay. If ground contact appears imminent, either pilot calls "CHECK MAX THROTTLE." Accomplish the first three steps simultaneously:

- Leave the autopilot and autothrottles connected and engage TO/GA for windshear recovery procedures.

If the autothrottles are not engaged:

- Aggressively advance throttles to mechanical stops to ensure maximum thrust is obtained with minimum delay. This max throttle setting is recommended until positive indications of recovery are confirmed. Positive indications of recovery include:
 - A. Altimeter and IVSI indicate level flight or a climb; and
 - B. Airspeed stable or increasing; and
 - C. Aural, visual warnings cease (stick shaker, windshear warning).

Note: If positive indications of recovery are confirmed while advancing the throttles to the mechanical stops, the power setting for continuous recovery to normal flight parameters may be limited to maximum rated thrust (i.e., go-around thrust) to avoid unnecessarily exceeding engine limitations.

- Rotate initially toward a 15° pitch attitude at normal rotation rate. Stop rotation immediately if stick shaker or buffet should occur. Roll wings level if in a turn to provide maximum lifting force.

Note: With the flight director in the TO/GA mode, the command bars will provide correct flight path guidance during a windshear encounter on takeoff.

- Monitor vertical speed, attitude, and altitude. If the aircraft develops a sink rate, increase pitch attitude smoothly and in small increments to achieve zero or positive vertical path. Always respect stick shaker and use intermittent stick shaker as the upper limit for pitch attitude.
- Do not change flap, gear, or trim position until terrain contact and/or loss of airspeed is no longer a factor.

Note: After liftoff or initiation of a go-around, adjust pitch to achieve a positive vertical flight path. Although exact criteria cannot be established, a target pitch attitude of 15° should provide a positive vertical path. Keeping a positive or zero rate of climb is the major objective. Airspeeds below normal must be accepted at least temporarily. If stick shaker is activated, pitch attitude should be reduced just enough to silence the stick shaker. Flight with intermittent stick shaker may be required to maintain a positive rate of climb. The pitch limit indicator on the PFD should be used as a maximum pitch reference during this maneuver. Control pitch attitude in a smooth, steady manner to avoid overshooting the attitude at which stall warning is initiated. Heavy and unusual control column forces (up to 30 lbs.) may be required.

- Speed is the least important item. If the pilot attempts to regain lost airspeed by lowering the nose, the combination of decreasing airspeed and decreasing pitch attitude produces a high rate of descent. Unless this is countered by the pilot, a critical flight path control situation may develop rapidly.
- The pilot monitoring should focus attention on vertical path, altitude, and pitch attitude. Inform the pilot flying of impending and negative vertical speeds by a callout of “SINK RATE.” The pilot flying should focus attention on pitch attitude and flying the aircraft.

Windshear ends when the tailwind component stops increasing.

Crew Coordination

The Pilot Flying should focus attention on flying the aircraft. In a windshear encounter, appropriate action should be taken in response to callouts.

The Pilot Monitoring should focus attention on airspeed, vertical speed, altitude, pitch attitude, glidepath deviation, and thrust. If significant deviations should occur, call them out immediately. In a windshear encounter, the Pilot Monitoring should call aircraft trends such as “CLIMBING” or “SINKING,” accompanied by radio altitude (AGL).

Pilot Reports

As soon as possible, report the encounter to the tower or controlling agency. The aircraft following might not have the performance required to recover from the same windshear encounter. The windshear may also be increasing in intensity making flight through it even more dangerous.

The pilot report should contain the following information:

- Specifically state either GAIN or LOSS of airspeed
- Magnitude of GAIN or LOSS
- Altitude at which shear was encountered
- Location of shear with respect to runway in use
- Aircraft type
- Use the term PIREP to encourage rebroadcast of the report to other aircraft

Critical remarks establishing severity such as “MAXIMUM THRUST REQUIRED, . . . ALMOST CONTACTED TERRAIN” etc. are also helpful.

TURBULENCE

WARNING: Severe turbulence should be avoided if at all possible. If severe turbulence cannot be avoided, a descent 4000 feet below optimum altitude is recommended to increase buffet margin.

The two major concerns when encountering turbulence are minimizing structural loads imposed on the aircraft and avoiding extreme, unrecoverable attitudes.

Autopilot

If turbulence is light to moderate, it is best to use the autopilot. If turbulence is greater than moderate, the autopilot may be used as long as its operation is monitored.

- Do not use altitude hold.
- Monitor pitch trim activity and be prepared to disengage if sustained trimming occurs.
- Do not aid or resist control motions when autopilot is engaged.

The B777 autoflight system control laws are designed to minimize large trim changes or high maneuvering loads. The autoflight system will allow altitude to vary by several hundred feet in response to strong up or down drafts to avoid excessive G-loading. It is possible to experience altitude deviations sufficient to cause an altitude alert caution without causing the autopilot to disengage.

Airspeed

The maximum turbulent airspeed is 280 KIAS or Mach .82, whichever is lower above 25,000 feet. Below 25,000 feet, a turbulent airspeed of 270 KIAS or minimum maneuvering, whichever is greater, should be observed. These speeds should be maintained as they provide the optimum tradeoff between buffet margin and structural loading. Slower speeds reduce the buffet margin, increase drag, and increase the out-of-trim condition due to fluctuations in airspeed. Lower speeds also increase the potential for turbulence to cause an extreme, unrecoverable attitude.

Sizable and rapid airspeed variations will likely occur depending on the severity of the turbulence but it is considered highly undesirable to chase airspeed either with elevator or throttle manipulations. Moderate variations, either above or below, are of minor consequence since some of the fluctuation of the instruments is a result of the turbulence itself and does not represent a real change in the aircraft's speed or altitude.

Attitude

The natural stability of the aircraft will work in a direction to minimize the loads imposed by turbulence. The pilot should rely on this natural stability and not become too greatly concerned about pitch attitude variations. Rapid and large aileron control inputs are permissible to hold the wings level, but pitch attitude must be controlled using only small to moderate elevator control inputs to avoid overstressing aircraft structure. Elevator control should be applied smoothly in a direction to resist motions away from the desired attitude, and the elevator should be returned to neutral when the aircraft is progressing toward the desired attitude.

Pitch attitude should be controlled solely with the elevator, never with stabilizer trim. An updraft or downdraft, which might tempt the pilot to change trim, can be expected to reverse itself in the next few seconds. If trim has been applied to counter the first draft, the second draft (which will likely be in the opposite direction) will exaggerate the out-of-trim condition. It is therefore considered desirable to leave the stabilizer trim alone in severe turbulence.

Thrust

Note: Use speedbrakes to slow if necessary. Adjust throttles only as necessary to avoid excessive airspeed variations. Use smooth power changes and maintain thrust as high as practicable. Do not chase airspeed.

Large variations in airspeed and altitude are almost certain to occur in severe turbulence. Set thrust to maintain the recommended penetration speed in level flight and minimize thrust changes.

Altitude

Because of the very high velocity updrafts and downdrafts in severe turbulence regions, large variations in altitude are almost certain to occur. Too much concern about these variations will merely lead to excessive control manipulations, causing large G load variations and unwanted airspeed excursions. Altitude should be allowed to vary within reasonable bounds. At high altitude, or during high-speed cruise at intermediate altitude, turbulence encounters may produce high-speed buffeting. The aircraft has been flown into the high-speed buffet regime many times during flight test in the process of determining and evaluating its qualities under these conditions. No unusual flight characteristics have been noted. However, to the uninitiated, the buffeting or shaking might be disconcerting, being somewhat similar in nature, but more severe, than the shaking that occurs under some conditions when speedbrake is extended.

When experienced in combination with severe turbulence, these effects might easily be incorrectly diagnosed as increased severity of the atmospheric disturbance, and result in an exaggerated assessment of the seriousness of the situation. Experience to date has shown that severe turbulence encounters at high altitude have caused positive Gs as high as 2.5. However, it is believed that if the recommended attitude control procedures are followed, high load factors need not be imposed.

Even though these procedures are used, an occasional encounter with high-speed buffeting in unexpected severe turbulence may be unavoidable above 30,000'. Such an occurrence should not cause great alarm, and should not be misinterpreted as a low speed stall with an accompanying rapid push-over for recovery, since any such action might aggravate the buffet situation by merely increasing the Mach number.

This tendency to encounter high-speed buffeting in severe turbulence is increased with increasing altitude. It is therefore apparent that climbing in an attempt to avoid an area of expected severe turbulence could lead to this type of buffeting difficulty if the turbulent region could not be completely topped.

Structural

Flap extension in an area of known turbulence should be delayed as long as possible, because the aircraft can withstand higher gust loads in the clean configuration. Diversion to another airfield is the best policy if severe turbulence persists in the area.

Procedure Summary

In a brief form, the procedures for flight in severe turbulence are summarized as follows:

- **Airspeed** - 270 KIAS below 25,000' and approximately 280 KIAS or approximately 0.82 Mach, whichever is lower at or above 25,000'. Severe turbulence will cause large and often rapid variations in indicated airspeed. Do not chase airspeed.
- **Autopilot** - May be used. Monitor pitch trim.
- If autopilot is disengaged, the following precautions should be observed:

Attitude - Maintain wings level and smoothly control pitch attitude. Use attitude indicator as the primary instrument. In extreme drafts, large attitude changes may occur. Do not use sudden large elevator control inputs.

Stabilizer - Maintain control of the aircraft with the elevators. After establishing the trim setting for penetration speed, do not change stabilizer trim.

Altitude - Allow altitude to vary. Large altitude variations are possible in severe turbulence. Sacrifice altitude in order to maintain the desired attitude and airspeed. Do not chase altitude.

- Disengage the autothrottles.
- Make an initial thrust setting of N_1 RPM for the target airspeed or Mach number (280 knots or M.82).
- Change thrust only in case of extreme airspeed variation.
- If moderate-to-severe turbulence is expected, the use of shoulder harness is recommended.
- When operating at altitudes below 10,000', 250 knots is acceptable.

COLD WEATHER OPERATION**Predeparture Check**

This check will determine the need for deicing. This check is usually accomplished by the flight crew during the normal walk-around inspection completed at the gate. Qualified ground personnel may also determine the need for aircraft deicing without the flight crew present.

The Predeparture check is a check of critical aircraft surfaces to ensure that they are free of any adhering ice, snow, slush, or frost. Critical aircraft surfaces include the following:

- Wings – Takeoff with light coatings of frost, up to 1/8 inch (3mm) in thickness on lower wing surfaces due to cold fuel is permissible. However, all leading edge devices, all control surfaces, and all upper wing surfaces must be free of snow, ice, slush, and frost.
- Fuselage – Thin hoarfrost is acceptable on the upper surface of the fuselage provided all vents and ports are clear. Thin hoarfrost is a uniform white deposit of fine crystalline texture, which is thin enough to distinguish surface features underneath, such as paint lines, markings or lettering.
- Tail
- Control Surfaces
- Engine Inlets
- Landing Gear and Gear Doors, Wheels and Brakes
- Air Conditioning Inlets/Exits and Outflow Valves
- Air data Sensors, Stall Vanes, Pitot Tubes and Static Ports

If these aircraft surfaces are not free of any adhering ice, snow, slush or frost, the aircraft must be deiced prior to departure.

In many cases, it may be necessary to start the engines and/or taxi to another location prior to deicing the aircraft. In situations such as this, it is permissible to start the engines and proceed to the deicing area with an accumulation of snow and/or ice on the aircraft. However, in no case will an aircraft taxi for takeoff without first ascertaining that the critical aircraft surfaces are free of any adhering ice snow, slush, or frost.

Ice, Frost and Snow Removal

Federal regulations prohibit takeoff when frost, snow or ice is adhering to critical aircraft surfaces. These regulations are based on the “clean” aircraft concept which requires a pre-takeoff contamination check to ascertain that critical aircraft surfaces (wings and control surfaces) are “clean” (free of adhering ice, frost or snow formations) and to determine that any formations not adhering to critical surfaces will blow off in the early stages of takeoff roll.

Deicing/Anti-Icing

When freezing precipitation conditions exist, a two step deicing/anti-icing procedure will be used. The first step, deicing, is the removal of contaminants from the aircraft using diluted Types I, II or IV fluids. The second step, anti-icing, is a separate fluid application to protect against ice, snow, slush or frost adhering to critical aircraft surfaces. Diluted Type I or 100% Type II or IV fluids are used for anti-icing.

When freezing precipitation conditions do not exist and are not anticipated, a one step, deicing, procedure will be used to remove any contaminants that may have adhered to the aircraft during a previous exposure to freezing precipitation.

Aircraft may be deiced/anti-iced with the engines and/or APU shutdown or operating. In either case the air conditioning supply switches and APU air switch should be selected off to prevent fumes from entering the cabin through the air conditioning system.

After completion of deicing/anti-icing, run engines and APU for approximately one minute with the air conditioning supply switches and APU air switch selected off to ensure that all deicing/anti-icing fluid has been cleared from the engines and APU. Consider making an announcement advising passengers that a trace of odor may be sensed but it is a normal condition of deicing.

Aircraft de-icing / anti-icing when required, will be accomplished in accordance with the Continental GMM Section 06-14.

If using de-icing fluid on the airplane exterior with APU or engines running:

Pack Switches OFF

To reduce pack wear, wait approximately 10 seconds for packs to completely shut down before positioning bleed switches to off.

Eng Bleed Switches (Engines Running)..... OFF

Reduces the possibility of fumes entering the air-conditioning system.

APU Bleed Switch (APU Running) OFF

Reduces the possibility of fumes entering the air-conditioning system.

Thrust Levers CLOSED

During de-icing, operate engines at idle to reduce the possibility of injury to personnel at inlet or exhaust areas.

Flaps UP

Prevents ice and slush from accumulating in the flap cavities.

Approximately 1 minute after completion of de-icing, restore engine and APU bleed air and pack operation.

Post Deicing/Anti-Icing Inspections

After the final anti-icing fluid application, personnel qualified in ground deicing inspection procedures will inspect critical aircraft surfaces to ensure that they are free of ice, slush, snow, or frost. Critical aircraft surfaces are listed in this section under Predeparture Check.

After completion of the inspection, the flight crew will be notified via radio or interphone communication that deicing/anti-icing and inspection procedures have been completed. This notification must contain the following four elements:

SAE Fluid Type:	I, II or IV
Fluid Mixture:	100/0 = 100% Fluid / 0% Water, 75 / 25 = 75% Fluid / 25% Water, 50 / 50 = 50% Fluid / 50% Water
Local Time:	(Hours/Minutes) of the beginning of the final anti-icing fluid application
Employee Number:	Of qualified person certifying that the deicing/anti-icing and inspection procedures were accomplished.

After receipt of this information, the flight crew will make the following aircraft logbook entries:

Block (2)	Aircraft Fleet Number
Block (3)	Flight Number
Block (4)	Employee Number of Captain
Block (5)	Station
Block (6)	Day of Month
Block (7)	Month
Block (8)	Aircraft anti-iced, type fluid, fluid mixture, local time (hours/minutes) of the beginning of the final anti-icing fluid application, employee number of qualified person certifying that the deicing / anti-icing and inspection procedures were accomplished. (e.g., "Aircraft Anti-Iced, Type IV / 0830 / 38802").

Note: The above notification and subsequent logbook entry are only required when freezing precipitation conditions exist. The situation may occur where the aircraft was exposed to freezing precipitation several hours prior to its next scheduled departure, such as an RON. The weather at departure time is such that no freezing precipitation conditions exist. In this situation the aircraft requires deicing only to clean any adhering ice, snow, slush or frost that may have previously accumulated on the aircraft. The aircraft does not have to be anti-iced because freezing precipitation conditions do not exist. In this case post deicing inspection procedures will be accomplished, however the flight crew does not have to be notified and the logbook entry is not required.

Pretakeoff Contamination Check

After completion of the post deicing preflight inspection and only when freezing precipitation conditions exist, if the aircraft is not airborne within 5 minutes of the beginning of the final application of anti-icing fluid (time reported), a pretakeoff contamination check is required. The pretakeoff contamination check, when required, must also be accomplished within 5 minutes of the commencement of the takeoff roll.

A pretakeoff contamination check is a close visual check by a qualified flight deck crew member or qualified ground personnel, of wing surfaces, leading edges, engine inlets, and other critical surfaces of the aircraft that are in view either from the flight deck or cabin (whichever provides maximum view). If surfaces have not been treated with FPD (Freezing Point Depressant) fluid, evidence of melting snow and possible freezing is sought. Also, evidence of any ice formation that may have been induced by taxi operations is sought. If the aircraft has been treated with FPD fluids, evidence of a glossy smooth and wet surface is sought. If, as a result of these checks evidence of ice, snow, slush or frost formations is observed, the aircraft should be returned for additional deicing.

The crewmember should perform the pretakeoff contamination check from the best vantage points available from within the aircraft. The best vantage points available for this check on the B777 aircraft have been identified as the cabin windows directly adjacent to the forward portion of the engine nacelles. Other vantage points can be used in this check; however, the identified best vantage points must be used.

The aircraft must be parked and not in motion for the entire time that the flight deck crew member is not at his or her station.

In some cases, it may become necessary to unseat passengers in the vicinity of the overwing vantage point area to conduct the pretakeoff contamination check. The flight deck crewmember making the check must ensure that all unseated passengers are resealed with seatbelts fastened before returning to the flight deck.

The exterior surface areas that may be viewed from inside the aircraft are deiced or anti-iced first so that during the pretakeoff contamination check it can be determined that other areas of the aircraft are clean since areas deiced or anti-iced first will generally freeze first.

In the darkness of night, the crewmember should use wing and other aircraft illumination lights on the outside of the aircraft. All lighting inside the cabin should be dimmed to improve the visibility through the cabin windows. The crewmember may, where practical, call upon the assistance of qualified ground personnel. If under any circumstance, the pilot in command cannot ascertain that the aircraft is clean, takeoff should not be attempted.

The decision to takeoff, following pretakeoff contamination check remains the responsibility of the pilot in command.

Anti-Icing Fluid Holdover Times

Holdover time is the estimated time an application of an anti-icing fluid will prevent the adherence of frost, ice, snow, or slush on the treated surfaces of an aircraft. Holdover time is obtained by anti-icing fluids remaining on the aircraft surfaces. Holdover time begins when the final anti-icing application commences, and expires when the anti-icing fluid applied to the aircraft wings, control surfaces, engine inlets, and other critical surfaces loses its effectiveness.

Due to their properties, SAE Type I fluids form a thin liquid wetting film, which provides limited holdover time, especially in conditions of freezing precipitation.

SAE Type II and IV fluids contain a pseudoplastic thickening agent, which enables the fluids to form a thicker liquid wetting film on external aircraft surfaces. This film provides a longer holdover time, especially in conditions of freezing precipitation.

The Guidelines To Hold Over Times table gives an indication as to the time frame of protection that could reasonably be expected under conditions of precipitation. However, due to the many variables that can influence holdover, these times should not be considered as minimums or maximums, as the actual time of protection may be extended or reduced, depending upon the particular conditions existing at the time.

Holdover Times Tables

The responsibility for the application of this data remains with the user.

Caution: This Table is for use in departure planning only, and should be used in conjunction with pre-takeoff contamination check procedures.

Caution: The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity and jet blast reduce holdover time below the lowest time stated in the range. Holdover time may be reduced when aircraft skin temperature is lower than OAT.

Caution: SAE Type I, II, and IV Fluids used during ground deicing / anti-icing are not intended for and do not provide protection during flight.

Note: For domestic operations using Types II or IV Fluid, Continental Airlines may use a diluted mixture for the first step of a two step (de-ice, then anti-ice) procedure, but uses only a 100% mixture of Type II or Type IV fluid for the second step (anti-ice).

Note: Takeoffs in conditions of moderate and heavy freezing rain are not approved. In lieu of an intensity report (ATC, ATIS, METAR, TAF, etc.) the following may be used to estimate the intensity of the freezing rain:

- **Light:** Scattered drops that, regardless of duration, do not completely wet an exposed surface, up to a condition where individual drops are easily seen.
- **Moderate:** Individual drops are not clearly identifiable; spray is observable just above pavements and other hard surfaces.
- **Heavy:** Rain seemingly falls in sheets; individual drops are not identifiable; heavy spray to height of several inches is observed over hard surfaces.

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Guidelines to Holdover Times								
Times in Hours : Minutes								
Information contained here in is applicable to light to moderate conditions only. Takeoff in heavy icing conditions prohibited.								
Weather Conditions	OA T ° Cel slu	Type Fluid						
		I ****	II 50% 75% 100%			IV 50% 75% 100%		
Frost * ***	Above 0°	:45	4:00	6:00	12:00	4:00	6:00	18:00
	0° to -3°		3:00	5:00	8:00	3:00	5:00	12:00
	-4° to -14°							
	-15° to -25°							
Freezing Fog * ***	Above 0°	:12 to :30	:15 to :30	:25 to 1:00	:35 to 1:30	:15 to :35	1:05 to 1:45	1:05 to 2:15
	0° to -3°	:06 to :15		:20 to :55	:20 to 1:05		:25 to :50	:20 to 1:20
	-4° to -14°			:15 to :20		:15 to :40		
	-15° to -25°							
Snowfall & Snow Grains *	Above 0°	:06 to :15	:05 to :15	:15 to :40	:20 to :55	:05 to :20	:20 to :40	:35 to 1:05
	0° to -3°	:06 to :15		:15 to :30	:20 to :45	:05 to :15	:20 to :35	:30 to :55
	-4° to -14°	:06 to :15	:15 to :25	:15 to :35		:15 to :25	:20 to :40	
	-15° to -25°			:15 to :30		:15 to :30		
Rain & Cold Soaked Wing	Above 0°	:02 to :05		:05 to :25	:05 to :40		:05 to :35	:10 to :50
Freezing Drizzle **	-3° & Above	:05 to :08	:05 to :15	:20 to :45	:30 to :55	:10 to :20	:30 to :50	:40 to 1:00
	-4° to -10°			:15 to :30	:15 to :45		:15 to :30	:20 to :45
Light Freezing Rain	-3° & Above	:02 to :05	:05 to :10	:10 to :20	:15 to :30	:05 to :10	:15 to :30	:25 to :40
	-4° to -10°				:10 to :30		:10 to :20	:10 to :25
Snow pellets, ice pellets, moderate & heavy freezing rain, hail & heavy snow	CAUTION: No Holdover time guidelines exist.							
* Type II and IV fluids may be used below -25°C, provided the freezing point is at least 7°C below the OAT. No holdover times exist.								
** If positive identification of freezing drizzle is not possible: Use holdover time for "Light Freezing Rain."								
*** Long ground stops with high humidity may cause an unacceptable dilution at the actual OAT.								
**** SAE Type I fluid / water mixture is selected so that the Freezing Point of the mixture is at least 10°C below OAT.								

Engine Start

When parked on a slippery area, make sure that chocks are applied both in front and behind the nose and main wheels prior to starting the engines. Chocks may not hold on slippery areas unless they are sanded. If chocks are not available for start, use sand or similar material and clear the airplane for potential movement.

Cold components such as gyros, gauges, actuators, etc., may function slower than normal until reaching operating temperatures.

Before starting engines, ensure engine cowl inlet and exhaust areas are clear of any excess de-icing fluid and/or ice accumulations. Use of de-icing solutions for removal of engine inlet ice should be kept to the minimum required.

During all cold weather starts, it is recommended that engines be warmed up at idle, or at thrust settings normally used for taxi, for five minutes before advancing throttles to takeoff thrust.

After each engine is started, engine anti-ice should be turned on if outside air temperature is less than 10°C (50°F) and icing conditions exist or are anticipated

Caution: Do not operate engine anti-ice when the total air temperature (TAT) is above 10°C (ANTI-ICE ON advisory message is displayed).

- Use normal start procedures; however, note that oil pressure may be slow to rise and will initially be higher than normal. There must be some indication of oil pressure by the time idle RPM is reached.
- Following engine shut down when no oil pressure indication by idle RPM, allow 10 to 15 minutes for internal heat to warm oil system.
- If ambient temperature is below -35°C (-31°F), allow engine to idle two minutes before changing thrust lever position.

Taxi

All engines must be operating on ice, snow, or slush-covered surfaces. When on slippery surfaces, make sure the parking brakes are released prior to commencing taxi. When power is applied, the airplane may slide forward even though the brakes are set.

Exercise caution when commencing taxi, as ramp areas may be especially slippery due to airplane servicing, de-icing, etc. Avoid high thrust settings when taxiing, especially when leaving the ramp area. If airplane response to throttle movement is slow while on snow or slush, allow a few seconds for the airplane to respond before applying more throttle. Advance power only as necessary to start the airplane moving, then retard the throttles smoothly to idle or to the minimum thrust necessary to maintain appropriate taxi speed.

Taxi speed should be as slow as practical on slippery surfaces and should be especially slow when approaching turns or stopping areas. Lead turns by as much as possible considering taxiway width. Nosewheel steering and braking action may both be affected by lack of traction on slick and frozen surfaces; the slower the speed, the better the traction. Avoid excessive nose gear steering deflection. Surface conditions may vary between taxiways and parking areas due to sanding and de-icing. Expect taxiways on bridges or other elevated areas to be more susceptible to ice formation than adjacent areas. An icy surface may be covered by a layer of snow. Melting ice or snow may cause rapid changes in traction. It is essential that the taxi speed be kept low enough that the airplane can be stopped in the space available. Reverse thrust may be used if necessary to assist in stopping.

Taxi slowly on contaminated taxiways to prevent snow and slush from impinging on wheel wells, flaps, and engines. Do not taxi through areas of deep snow or deep slush. A crowned, slippery taxiway or a slick crosswind taxiway may cause sideways slipping or weathervaning into the wind. Taxi as close as possible on the centerline and avoid large nose steering inputs. Be aware of snowbanks, as extended flaps are particularly susceptible to damage from such hazards. Be alert for obscured runway, taxiway, or ramp markings and lights.

Caution: During ground operations in icing conditions, the engines must be run up momentarily to a minimum of 50% N_1 at intervals not to exceed 15 minutes. Prior to takeoff under these conditions, perform an engine run-up as above and observe that N_1 , RPM, and EGT indicate normal engine operation.

Taxi with flaps up. With flaps extended, the flap carriages, fore flap, and aft flap tracks are subjected to slush and water from main gear wheels. The jackscrew fairings on the ends of each flap are subject to filling with slush, as are the leading edge slat tracks.

The nose steering wheel should be exercised in both directions during taxi to permit the circulation of warm hydraulic fluid through the steering cylinders. This will minimize the lag encountered in steering during low temperatures.

Be aware that blasted snow or ice can cause damage at considerable distances. Maintain increased separation behind other airplanes. Expect they may also require an engine run-up to counteract ice formation

If a clear, dry run-up area is available during taxi or on the ramp, make a preliminary power run on in order to prevent a rejected takeoff, which may occur if the check is made on a slick runway.

The shortest possible route to the point of takeoff should be used to conserve fuel and minimize the amount of ice fog generated by the jet engines. This fog may delay takeoff by lowering the visibility below takeoff minimums.

Caution: Use extreme caution when taxiing over ice-covered taxiways or runways, as excessive speed or high crosswinds may start a skid. Attempt all turns at reduced speed.

Taxi speed should be kept as slow as possible to reduce the chance of the nose gear tires throwing snow and slush up to the ram air inlet area.

Caution: When operating the wing flaps during low temperatures, the flap position indicator should be monitored for positive movement. If the flaps should stop, the flap control lever should be placed immediately in the same position as indicated.

Before Takeoff

Prior to takeoff, recheck flight controls and trim for freedom of movement. Use caution when taxiing onto the runway for takeoff. The approach end of the runway may be more slippery than other areas due to melting and refreezing of snow or ice following previous takeoffs. In addition, painted surfaces and normal accumulation of fuel, oil, and rubber are made more slippery when coated with moisture (i.e., water or slush).

Takeoff

Check latest field conditions prior to takeoff. Slush and snow conditions change rapidly. A runway is contaminated when more than 25% of the required field length, within the width being used, is covered with $\frac{1}{4}$ inch or more of slush or wet snow, or 2 inches or greater of dry snow.

- Slush is snow saturated with water which splatters when firmly stepped on.
- Wet snow is compactible and will stick together as in a snowball.
- Dry snow is light powdery snow which can be blown about freely. Snow not considered dry will be considered wet.
- Icy runway is a runway covered with cold ice or wet melting ice. Temperatures rising above 0°C, initial pavement temperatures above 0°C, or solar radiation can produce wet melting ice. Melting ice or hard packed snow with a melting or water covered surface may have poor to nil braking action capability.

A reduced thrust takeoff is not permitted when the runway is contaminated by water, ice, slush, or snow. On contaminated runways use higher takeoff flap settings (as permitted by takeoff performance) to reduce takeoff roll.

Align the airplane with the runway centerline and ensure that the nosewheel is straight before applying power for takeoff. Under severe icing conditions, takeoff should be preceded by a static run-up to as high a thrust level as practical with observation of N_1 and EGT to assure normal engine operation. On slippery surfaces, ensure the parking brakes are released prior to setting takeoff power to preclude a takeoff with the parking brakes set.

With a contaminated runway, a static takeoff should be performed. Advance throttles to 60 N_1 for 10 seconds. If the airplane starts to move due to poor braking conditions, release the brakes and proceed with a rolling takeoff. Check all engine instruments for proper indications during the early part of this step,

Asymmetrical thrust can adversely affect directional control on slippery runways. Throttle alignment at partial power may not assure alignment at takeoff power as engine pairs may have different spool-up rates.

On slippery runways, apply some nose down elevator to improve nosewheel traction and directional control until rudder control becomes effective for steering the airplane. Excessive forward control column pressure should be avoided and, as speed increases, the forward pressure on the control column should be reduced to lessen the possibility of nosewheel spray being ingested into the engines when operating on wet, or slush and snow-covered runways.

To maintain the heading during takeoff roll, recognize initial heading deflections early and correct by small rudder pedal steering inputs. Do not use differential thrust

Automatic Ice Detection System

The automatic ice detection system detects aircraft icing in flight. Automatic ice detection is inhibited on the ground. The system provides signals to control the engine and wing anti-ice systems when those systems are in the automatic mode.

Wing Anti-Ice Operation

The wing anti-ice system may be used as a de-icer or anti-icer in flight only. The primary method is to use the automatic ice detection system that acts as a de-icer by allowing the ice to accumulate before turning wing anti-ice on. This procedure provides the cleanest airfoil surface, the least possible run-back ice formation, and the least fuel penalty. The second method is to select the WING ANTI-ICE selector **ON** when wing icing is possible and use the system as an anti-icer.

Ice accumulation on the flight deck windshield frames, windshield center post, windshield wiper post, or side windows can be used as an indication that airframe icing conditions exist.

Caution: Do not operate wing anti-ice when the total air temperature (TAT) is above 10°C (ANTI-ICE ON advisory message is displayed).

The wing anti-ice (WAI) annunciation is displayed below the EICAS N₁ indication when a wing anti-ice valve is open.

In flight, when the WING ANTI-ICE selector is in **AUTO**, wing anti-ice system operation is automatic. When ice is detected, the wing anti-ice valves open and bleed air is automatically supplied to the affected slats. When ice is no longer detected the wing anti-ice valves close and bleed air is no longer supplied to the slats. If one wing anti-ice valve fails closed, the wing anti-ice system automatically closes the other valve to prevent asymmetrical wing anti-icing. During the takeoff phase of flight, Automatic wing anti-ice operation is inhibited for up to 10 minutes after takeoff and while in the takeoff engine thrust reference mode. The wing anti-ice inhibit is removed after 10 minutes or when climb thrust reference is selected. Manual wing anti-ice operation is not affected by this inhibit.

Wing Anti-Ice System Manual Operation

In flight, turning the WING ANTI-ICE selector **ON** opens the wing anti-ice valve in each wing, allowing bleed air to flow from the bleed air manifold to the affected slats.

The aircraft is capable of continued safe flight and landing in icing conditions in the event of in-flight failure of the wing anti-ice system.

Engine Anti-Ice Operation

Engine icing often forms when not expected, and may occur when there is no evidence of icing on the windshield or other parts of the aircraft. Once ice commences to form, an appreciable accumulation can build with surprising rapidity. Although one bank of clouds may not cause icing, another bank, which to all appearances is similar, may induce icing. Therefore the engine anti-icing system should be left in the **AUTO** or **ON** position whenever icing is possible.

During flight in moderate to severe icing conditions for prolonged periods with N_1 settings at or below 70%, or when fan icing is suspected due to high engine vibration, the fan blades must be cleared of any ice. Perform the following procedure on both engines, one engine at a time: reduce thrust toward idle then increase to a minimum of 70% N_1 for 15 seconds every 15 minutes.

The Engine Anti-Ice (EAI) annunciation appears above the EICAS N_1 indication when an engine anti-ice valve is open.

Note: Failure to follow the recommended anti-ice procedures can result in engine stall, over temperature or engine damage.

Descent In Icing Conditions

Engine Inlet Icing

A primary ice detection system is installed and the automatic feature is normally used.

The use of anti-ice and the increased thrust required will increase the descent distance. Therefore, proper descent planning is necessary to arrive at the initial approach fix at the correct altitude, speed, and configuration. The anticipated anti-ice altitude should be entered on the DESCENT FORECAST page to assist the FMC in computing a more accurate descent profile.

Engine icing may form when not expected and may occur when there is no evidence of icing on the windshield or other parts of the aircraft. Once ice starts to form, accumulation can build very rapidly. Although one bank of clouds may not cause icing, another bank, which is similar, may induce icing. Therefore, the engine anti-icing system should be in auto or turned ON, if used manually, whenever icing conditions exist or are anticipated.

Note: Failure to follow the recommended anti-ice procedures can result in engine stall, over temperature or engine damage.

Wing Icing

A primary ice detection system is installed and the automatic feature is normally used.

If operating manually, wing anti-icing should be used as a de-icing system by turning it on after an appreciable amount of ice has formed.

Cold Temperature Altitude Corrections

Pressure altimeters are calibrated to indicate true altitude under International Standard Atmosphere (ISA) conditions. Any deviation from ISA will result in an erroneous reading on the altimeter. In the case when the temperature is higher than ISA, the true altitude will be higher than the figure indicated by the altimeter, and the true altitude will be lower when the temperature is lower than ISA. **The altimeter error may be significant and becomes extremely important when considering obstacle clearances in very cold temperatures.**

In conditions of extreme cold weather, pilots should add the values derived from the Altitude Correction Chart to the published procedure altitudes, including minimum sector altitudes and DME arcs, to ensure adequate obstacle clearance. Unless otherwise specified, the destination aerodrome elevation is used as the elevation of the altimeter source.

With respect to altitude corrections, the following procedures apply:

1. IFR assigned altitudes may be either accepted or refused. Refusal in this case is based upon the pilot's assessment of temperature effect on obstruction clearance.
2. IFR assigned altitudes accepted by a pilot shall not be adjusted to compensate for cold temperature, i.e., if a pilot accepts "maintain 3000" an altitude correction shall not be applied to 3000'.
3. Radar vectoring altitudes assigned by ATC are temperature compensated and require no corrective action by pilots.
4. When altitude corrections are applied to a published final approach fix, crossing altitude, procedure turn or missed approach altitude, pilots should advise ATC how much of a correction is to be applied.

ALTITUDE CORRECTION CHART

A/D Temp °C	HEIGHT ABOVE THE ELEVATION OF THE ALTIMETER SOURCE (FEET)													
	200	300	400	500	600	700	800	900	1000	1500	2000	3000	4000	5000
0°	0	20	20	20	20	40	40	40	40	60	80	140	180	220
-10°	20	20	40	40	40	60	80	80	80	120	160	260	340	420
-20°	20	40	40	60	80	80	100	12	120	180	240	380	500	620
-30°	40	40	60	80	100	120	140	140	160	240	320	500	660	820
-40°	40	60	80	100	120	140	160	180	200	300	400	620	820	1020
-50°	40	80	100	120	140	180	200	220	240	360	480	740	980	1220

Note: Values are to be added to published altitudes.

Example:

Aerodrome Elevation 2262' Aerodrome Temperature -50°

	ALTITUDE	HAA	CORRECTION	INDICATED ALTITUDE
Procedure Turn	4000 feet	1738 feet	+420 feet	4420 feet
FAF	3300 feet	1038 feet	+240 feet	3540 feet
MDA Straight-in	2840 feet	578 feet	+140 feet	2980 feet
Circling MDA	2840 feet	578 feet	+140 feet	2980 feet

Procedure Altitudes And Current Altimeter Setting

All altitudes published on the Jeppesen Approach Charts are minimum altitudes which meet obstacle clearance requirements when international standard atmosphere (ISA) conditions exist, and when the aircraft altimeter is set to the current altimeter setting for that aerodrome. The altimeter setting may be a local or a remote setting when so authorized on the instrument approach chart. A current altimeter setting is one provided by approved direct reading or remote equipment, or by the most recent routine hourly weather report. These readings are considered current up to 90 minutes from the time of observation. Care should be exercised when using altimeter settings older than 60 minutes or when pressure has been reported as falling rapidly. In these instances, a value may be added to the published DH/MDA in order to compensate for falling pressure tendency (0.01 inches mercury = 10 feet correction). Under conditions of extreme cold, corrections to the published altitudes should be applied to ensure adequate obstacle clearance. When an authorized remote altimeter setting is used, the altitude correction shall be applied as indicated.

Corrections For Temperature

Altitude corrections to compensate for cold temperatures are obtained from the Altitude Correction Chart. These corrections should be applied to all procedure altitudes.

Landing

Refer to Landing On Wet Or Slippery Runways, this section.

Taxi-In

Caution: Structures are possibly colder than OAT due to cold soak at altitude. At low speed, minimize the intensity and duration of reverse thrust. After landing and/or if taxiing through water or slush, do not retract flaps beyond 20. A visual inspection should be accomplished to determine that the flaps and flap areas are clear of ice before further flap retraction. The jackscrews are especially vulnerable to water and slush.

A buildup of ice on the leading edge devices may occur during ground operations involving use of reversers in light snow conditions. Snow is melted by the deflected engine gases and may refreeze as clear ice upon contact with cold leading edge devices. This buildup, which is difficult to see, occurs in temperature conditions at, or moderately below, freezing. Crosswind conditions can cause the ice buildup to be asymmetrical, resulting in a tendency to roll at higher angles of attack during subsequent takeoffs. If ice accumulation is suspected during taxi-in, have the leading edges inspected upon gate arrival.

On the ground with either engine operating, the probes are automatically heated. Engine anti-ice may be used during taxi if conditions warrant.

Parking

The aircraft should be parked headed into the wind, if practical, particularly in driving rain and snow conditions. Protective plugs and covers, etc. should be installed. If brakes have been used immediately prior to parking, do not set brakes until sufficiently cooled.

**Securing For Overnight Or Extended Period
(Aircraft Unattended)**

If remaining overnight at off-line stations or at airports where normal support is not available, the flight crew should arrange for, or ascertain, that the following actions have been accomplished:

Outflow Valve Switches MAN

Outflow Valve Manual Switches..... CLOSE

Position outflow valves fully closed to inhibit intake of snow and ice.

Wheel Chocks.....CHECK IN PLACE

Parking Brake..... OFF

Release parking brake to eliminate possibility of brakes freezing.

Protective Covers..... INSTALL

Install protective covers and plugs to protect the aircraft and engines from snow and ice.

Water Storage Containers.....DRAIN

Drain all water tanks and containers to protect from freezing.

ToiletsDRAIN

Drain all toilets to protect from freezing.

Doors and Side Windows CLOSE

HOT WEATHER OPERATION

High ground temperatures have adverse effects on passenger and crew comfort and generally decrease aircraft performance. Every effort should be made to keep the interior of the aircraft as cool as possible. All doors to the aircraft should be kept closed as much as possible. The flight deck windows must be kept closed and cargo doors should not be left open longer than necessary. The flight attendants should verify all gasper outlets are opened, reading lights extinguished, and window shades closed on the side of the aircraft exposed to the sun. All air conditioning packs should be used (when possible) for maximum cooling.

If cooling air is available from an outside source, the supply should be plugged in immediately after engine shutdown and should not be removed until just prior to engine start.

Consideration should be given to reducing the heat generated in the flight deck. Window heat, radar and other electronic components which contribute to a high temperature level in the flight deck should be turned off while the airplane is on the ground. Windshield air, foot vents, and all air outlets in the flight deck should be open.

To attain maximum cooling on the ground, follow these procedures:

During extended ground operations prior to flight deck preparation, consideration should be given to reducing the heat being generated on the flight deck. Window heat, radar, and other electronic components that contribute to a high temperature level on the flight deck may be turned off. All the flight deck air outlets should be open.

Both packs should be used (when possible) for maximum cooling. Recirculation fans should be on for maximum cooling capacity. To maximize the cooling capacity of the air conditioning system, the flight deck side windows and all doors, including cargo doors, should be kept closed as much as possible. Flight deck cooling can be improved by closing the flight deck door and lowering the side trays adjacent to the pilot seats.

To attain maximum cooling on ground, follow these procedures:

IF External (Pre-conditioned) Air Is Available:

APU Bleed Air Switch.....AUTO

Recirculation Fan Switches..... OFF

Air Conditioning Pack Selectors..... OFF

IF External (Non Pre-conditioned) Air Is Available:

APU Bleed Air Switch.....AUTO

Recirculation Fan Switches..... ON

Air Conditioning Pack Selectors.....AUTO

IF The APU Is The Only Source Of Pneumatic Air Pressure:

APU Bleed Air Switch.....AUTO

Pack SwitchesAUTO

Recirculation Fan Switches..... ON

Compartment Temperature Selectors (AS DESIRED)

Taxi Out

The greatest wear on the carbon type brakes installed on the Boeing 777 occurs during taxi out holding continuous brake pressure, “riding the brakes.”

Therefore excessive use and riding of the brakes should be avoided. Conditions permitting, allow the aircraft to accelerate to maximum taxi speed and, then brake to a very slow taxi speed and release the brakes completely.

LANDING ON WET OR SLIPPERY RUNWAYS**Touchdown and Landing Roll**

The flight crew must be aware of the condition of the runway with respect to snow, ice, slush, or precipitation. The most favorable runway in relation to surface condition, wind, and weather should be used. In very general terms, landing on a wet runway increases the stopping distance approximately 1000 feet over a dry runway, and landing on an icy runway increases the stopping distance by more than 3000 feet. Use maximum landing flap configuration when landing on a contaminated runway.

If a landing is planned on a runway contaminated with snow, slush, standing water, or during heavy rain, the following factors must be considered: available runway length; visibility of runway markers and lights; snowbanks and drifts along the runway; wind direction and velocity; crosswind effect on directional control; braking action; possibility of effect on the airplane from slush and water spray (engine ingestion, damage to flaps, gear doors, etc.); and the probability of hydroplaning and its effect on stopping distances.

A common form of hydroplaning is dynamic hydroplaning. It occurs when there is standing water on the runway surface. Water with a depth of about one-tenth of an inch acts to lift the tire off the runway surface. This condition can progress to where the tires no longer contribute to directional control and braking action is nil.

The minimum dynamic hydroplaning speed of a tire has been determined to be 8.6 times the square root of the tire pressure in pounds per square inch. For example, with a main wheel tire pressure of 180 psi, the calculated hydroplaning speed is approximately 115 knots. With a nosewheel tire pressure of 155 psi, the calculated hydroplaning speed of the nosewheel tire is approximately 107 knots. Nosewheel tire hydroplaning might be encountered while executing a high speed turnoff. The calculated hydroplaning speed referred to is for the start of dynamic hydroplaning. Once hydroplaning has started, it may persist to a significantly slower speed.

Braking action can become inhibited due to chemical de-icers on an icy runway. The chemicals provide a watery film over snow and ice that results in an extremely low coefficient of friction.

Blowing or drifting snow can create optical illusions or depth perception problems during landing or taxi-in. In crosswind conditions, they may create a false impression of airplane movement over the ground. It is possible to have an impression of no drift when in fact a considerable drift may exist. When landing under these conditions, runway markers or runway lights can help supply the necessary visual references.

When it has been established that a safe landing can be made, the airplane must be flown with the objective of minimizing the landing distance. The approach must be stabilized early. Precise control over drift and approach speeds is mandatory. Execute a missed approach if the drift condition cannot be controlled prior to touchdown. When making the transition to visual reference for landing, continue to utilize the glideslope and VASI information to control the glidepath as wet windshields and snow-covered surfaces may distort depth perception. The airplane should be flown firmly onto the runway at the aiming point. Avoid holding off.

On touchdown, take positive action to lower the nose gear to the runway and maintain moderate forward pressure on the control column to assist in directional control. Avoid excessive forward control column pressure in order to retain maximum braking effectiveness and to reduce the possibility of nose wheel spray. Check that the auto speedbrake deploy immediately after the main gear contacts the runway. Maintain centerline tracking, ensure spoiler deployment. Autobrakes, if available, will be used, with the maximum setting if required. Arm the autobrake system before landing by selecting position desired deceleration level. At main gear touchdown, after wheel spin-up, the autobrake system smoothly begins to apply symmetrical braking and to control airplane deceleration.

The autobrake system can be disarmed by application of pressure on any brake pedal; stowing of speedbrake handle to full forward detent, or turning autobrake selector to OFF and take over manual braking.

If the autobrake system is not available, complete the landing roll using manual braking.

Without autobraking, apply brakes smoothly and symmetrically immediately after nose gear touchdown, with moderate-to-firm pedal pressure and hold until a safe stop is assured. Do not cycle the brake pedals. The brakes and thrust reverser's should be applied together. The anti-skid system will stop the airplane for all runway conditions in a shorter distance than is possible with brake pedal modulation. The anti-skid system adapts pilot-applied brake pressure to runway conditions by sensing an impending skid condition and adjusting the brake pressure to each individual wheel for maximum braking effort. When brakes are applied on a slippery runway, several skid cycles may occur before the anti-skid system establishes the right amount of brake pressure for the most effective braking.

If the pilot modulates the brake pedals, the anti-skid system is forced to readjust the brake pressure to re-establish optimum braking. During this readjustment time, braking efficiency is lost.

Due to the low coefficient of friction on extremely slippery runways at high speeds, the pilot is confronted with a rather gradual increase in deceleration, and may interpret the lack of an abrupt sensation of deceleration as a total anti-skid failure.

Avoid large, abrupt steering and rudder pedal inputs that may lead to over control and skidding. Rudder control is relatively effective down to 40-60 knots. Maintain directional control and wings level with appropriate control inputs. Keep light forward pressure on the control column to improve nose wheel steering effectiveness.

Use thrust reversers as soon as possible during landing roll. Thrust reversers are most effective at high speed.

At approximately 80 knots, begin a gradual reduction of reverse thrust to be at idle reverse when reaching taxi speed.

Under emergency conditions, maximum reverse thrust may be used to a complete stop.

Reverse Thrust and Crosswind

The reverse thrust side force and a crosswind can cause the aircraft to drift to the downwind side of the runway if the aircraft is allowed to weathervane into the wind. As the aircraft starts to weather vane into the wind, the reverse thrust side force component adds to the crosswind component and drifts the aircraft to the downwind side of the runway. Main gear tire cornering forces available to counteract this drift will be reduced when the anti-skid system is operating at maximum braking effectiveness for existing conditions. To correct back to the centerline, reduce reverse thrust to idle reverse (if more than idle reverse was used), and release the brakes. This will minimize the side force component without the requirement to go through a full reverser actuating cycle, and provide the total tire cornering forces for realignment with the runway centerline. Use rudder steering and differential braking, as required, to prevent overcorrecting past the runway centerline. When re-established on the runway centerline, reapply steady brakes and reverse thrust as required to stop the aircraft.

Turnoff

Do not attempt to turn off from a slippery runway until speed is reduced to a safe level to prevent skidding. Anticipate low friction when approaching the touchdown zone at the far end of the runway. The touchdown zone may be very slippery when wet due to heavy rubber and oil deposits.

PHASE	RECOMMENDED PROCEDURE	REMARKS
Approach	<p>Fly final approach with the aircraft positioned on the glide path, on runway centerline and at the speed recommended for existing conditions.</p> <p>Arm autobrake system by selecting position No. 3 or 4.</p> <p>Arm speedbrake.</p> <p>Consider a go-around if zero drift conditions cannot be established prior to flare.</p>	
Flare	<p>Do not float or allow drift to build up during flare.</p> <p>Use crab technique on slippery runways.</p>	
Touchdown	<p>Hold crab through touchdown.</p> <p>Accomplish a firm touchdown, as near centerline as possible.</p> <p>Get the wheels on the runway at approximately 1,500' from the approach end of the runway. The aircraft should be flown firmly onto the runway at the aiming point even if the speed is excessive.</p> <p>If a touchdown at the far end of TDZ is likely, consider a go-around.</p>	<p>A firm touchdown will improve wheel spin-up on slippery runways.</p> <p>Deceleration on the runway is about three times greater than in the air. Do not allow the aircraft to float in an attempt to reduce speed.</p>
Transition to Braking Configuration (expedite all items)	<p>Check that the speedbrakes deploy immediately after main gear touchdown.</p> <p>Fly the nose gear onto the runway by relaxing back pressure. After nose gear touchdown hold light forward control column pressure.</p> <p>Immediately select reverse thrust.</p> <p>Without autobraking, immediately after nose gear touchdown, smoothly apply moderate-to-firm, steady braking until a safe stop is assured.</p> <p>The autobrake system will begin symmetrical braking after wheel spin-up. Either pilot can disarm the system and take over manual braking at any time by applying normal pedal braking.</p>	<p>If the speedbrake lever fails to actuate automatically, immediately actuate it manually.</p> <p>Speedbrakes release approximately 70% of wing lift.</p> <p>Decreasing lift, increases gear loading, improves wheel spin-up and directional stability. Aerodynamic braking is relatively ineffective.</p> <p>Reverse thrust is most efficient at high speeds.</p> <p>Do not cycle brake pedals.</p>

PHASE	RECOMMENDED PROCEDURE	REMARKS
Rollout	Maintain light forward control column pressure. Keep the wings level. Use brakes as above. Maintain directional control primarily with rudder.	Improves directional control. Improves braking and traction.
Skid or Loss of Directional Control	Immediately release brake pressure. Reduce to reverse thrust idle (if more than idle reverse was used). Keep the wings level, Immediately apply nose wheel steering, rudder, and differential braking to bring the aircraft to the centerline. When rolling parallel with the runway and near the centerline, apply reverse thrust and brake pressure to develop maximum braking.	Rudder control is effective down to 60-40 knots. Avoid large abrupt steering inputs. Optimum nose wheel steering angle varies with runway condition and speed, and is about 1 to 2 degrees for a very slippery runway.
Turnoff	Reduce speed to a safe level prior to turnoff.	End of runway may be very slippery when wet due to heavy rubber and oil deposits.

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ADVANCED MANEUVERS**Background And Introduction**

Over the last decade, loss of control accidents, have been the second leading cause of world wide aviation fatalities. A sound understanding of the causal factors, aerodynamic principles involved, and proven recovery techniques is critical in order for the crew to successfully respond to these kinds of events. For the purposes of this section, the following terms are considered synonymous in connotation: Advanced Maneuver, Upset Event, Loss of Control, or Unusual Attitude. Additionally, Approach to Stall and Full Stall events are also categorized as Advanced Maneuvers by virtue of the similarities of recovery techniques employed in all these kinds of events. Advanced Maneuver events can be defined as the unintentional exceedence of any of the following conditions:

- Pitch Attitude greater than:
 - 25 degrees nose up
 - 10 degrees nose down
- Bank Angle greater then 45 degrees
- Within above parameters but airspeed inappropriate for configuration (Approach to Stall or Full Stall)

Any of the following sources may be directly or indirectly responsible for placing the aircraft in an Advance Maneuver event:

- Wake turbulence
- Weather produced turbulence, windshear, wave
- Autopilot malfunction / mode confusion
- Aircraft systems malfunction
- Pilot disorientation, confusion, inattention
- Inappropriate control input.

Regardless of the specific cause(s) of the event, the following review and procedures provide background information and a logical progression for recovering the airplane. The sequence of actions is for guidance only and represents a series of options to be considered and employed depending on the specific situation. Not all the actions may be necessary once the recovery is underway and pilot judgement and evaluation of the situation remains paramount.

Angle of Attack (AOA)

One of the fundamental principles involved in all recovery actions is the control of the aircraft's Angle of Attack (AOA). Angle of attack is defined as the angular difference between the chord line of the wing and the relative wind. The chord line is a straight line connecting the leading and trailing edges of the airfoil. Although not displayed in a numerical value on the flight instruments, the two AOA vanes of the aircraft provide this critical data to numerous systems on the aircraft, including the generation and display of the Pitch Limit Indication (PLI) on the PFD. The PLI graphically displays the proximity of the stick shaker activation point in relationship to the aircraft's current pitch attitude for existing flight conditions.

Approach To Stall Condition

Stall warning is readily identifiable by the pilot as a result of either aircraft produced slow speed buffet or from the artificially produced stick shaker. Two independent stick shakers provide a warning of *impending* stall by vibrating the control columns. They are activated when the airplane symbol is on or above the PLI. Stick shaker activation will occur in close proximity to initial buffet for all flap positions, including flaps up for all weights and altitudes. At cruise Mach numbers, stick shaker activation will occur just after reaching initial buffet. During initial stages of stall, local airflow separation begins at the root section of the wing and results in airframe buffeting, providing a natural warning of an approach to stall. Initiate recovery from an approach to stall or full stall at the earliest recognizable warning regardless of the source. The approach to stall is preceded by the **AIRSPEED LOW** EICAS message and the airspeed box on the PFDs turning amber when the airspeed is below minimum maneuvering speed. An approach to stall situation can be recognized by the indicated airspeed being above the red and black minimum speed band on the PFD and the airplane symbol on the PFD being at or near the PLI. It is important to note the difference between this **approach to stall** condition and a **full stall** condition. In an approach to stall, the aircraft has sufficient power to recover with negligible loss of altitude when encountered at low to mid altitudes. However, at high altitudes, it *may* be necessary to decrease pitch attitude slightly below the horizon in order to achieve acceleration. In contrast, during a **full stall** condition, altitude *must* be sacrificed in order to achieve flying airspeed.

Full Stall Condition

If the approach to stall condition is further aggravated by additional increase in AOA, a fully stalled condition will develop. A stalled condition can exist at any attitude and may be recognized by continuous stick shaker activation accompanied by one or more of the following:

- Buffeting, which could be heavy at times
- Lack of pitch authority and/or roll control
- Inability to arrest descent rate.

In a full stall condition the indicated airspeed will be below the top of the red and black minimum speed band and the airplane symbol on the PFD will be well above the PLI. As the full stall develops, aircraft pitch increases with decaying airspeed and increase in AOA. When fully stalled, the aircraft pitch will decrease to a nose low attitude while maintaining a high AOA and an excessive sink rate. In a full stall situation, AOA must be reduced immediately regardless of the altitude. Release any back pressure on the yoke and apply forward elevator as necessary. Nose down stab trim may be required. Without this prompt AOA reduction, even the application of maximum thrust is not likely to recover the aircraft, or if recovery eventually occurs, it will have resulted in a significant loss of altitude. Unlike the approach to stall, the recovery of a full stall condition will result in altitude loss in order to achieve an AOA necessary for recovery.

Bank Angle And Lateral Control

The roll authority characteristics of the B777 are excellent and use a combination of ailerons, spoilers, flaperons and rudder to maintain lateral control. Control wheel forces do not change with airspeed changes. The ailerons are locked out at high speed to improve handling characteristics. Bank angle protection provides roll control wheel inputs when the airplane exceeds 35 degrees angle of bank, regardless of what caused the roll exceedence. When this boundary is exceeded, the control wheel forces will attempt to roll the aircraft back to within 30 degrees of level.

Rudder surface deflections are proportional to rudder pedal movements and provide conventional yaw control. Pedal forces increase as pedal displacement increases. Pedal forces do not change with airspeed changes. The rudder ratio changer automatically reduces rudder deflection (for a given pedal input) as airspeed increases. The B777 does not have any "crossover speed" issues. Lateral control can be maintained throughout the aircraft speed envelope (provided flap configuration minimum maneuvering speeds are honored) even if the rudder is fully deflected to the maximum limit allowed by current airspeed.

The use of rudder to aid in roll control should be used cautiously, given it's ability to induce significant yaw and roll rates, which may be excessive or counter productive for a particular recovery.

Recoveries

For purposes of defining recovery procedures and techniques, all advanced maneuver events may be classified into one of three basic recovery categories:

APPROACH TO STALL / FULL STALL RECOVERY
NOSE HIGH RECOVERY (ANY BANK ANGLE)
NOSE LOW RECOVERY (ANY BANK ANGLE)

Normally, the Pilot Flying (PF) will continue to manipulate the controls during any advanced maneuver event in order to achieve recovery. This does not preclude assistance or intervention on the controls by the Pilot Monitoring (PM) in unique situations, such as additional control input force being required, a flight control system being jammed, or the PF being incapacitated. Although each individual situation will govern their specific application, the key to the successful recoveries of all advanced maneuver events is based upon three fundamental actions: **UNLOAD**, **ROLL**, and **PULL**.

If the airplane is in an approach to stall or full stall condition, stall recovery must be completed prior to accomplishing any nose high/low upset recovery. The timely accomplishment of the following duties is necessary to effect a safe and expeditiously recovery:

- **Assess and Identify the Situation**

FOR ALL RECOVERIES first check the PFD and EICAS displays to assess and identify the aircraft attitude, airspeed, altitude and thrust setting. Confirm this information by cross checking the standby instruments. If there is a disagreement between the displays, immediately cross check with the other pilot's displays to confirm which information is correct. In the absence of any instrument off flags or EICAS messages, any single display that is in disagreement with the two other displays should be considered as invalid data. Be aware of any EICAS messages indicating a problem with the flight instrument display information or related systems. **Conflicting aircraft data displays have been the source of a number of aircraft upsets/loss of control accidents.**

- **Disconnect Autopilot and Autothrottle**

FOR ALL RECOVERIES disconnect the autopilot and autothrottles. Although the autopilot and autothrottle may be capable of maintaining control of the aircraft in an approach to stall condition, if the aircraft is fully stalled, or if the aircraft is excessively nose high/low, the autopilot cannot be relied upon to provide correct inputs. Additionally, manual manipulation of the controls insures a more positive method of recovery by crew interaction. For these reasons, and to standardize and simplify all types of advanced maneuver recoveries, both the autopilot and autothrottles will be disconnected during all recoveries.

Use the yoke disconnect button to disengage the autopilot. **Do not** use the MCP A/P DISENGAGE bar as this will disable the roll envelope bank angle protection. This protection should always be left engaged, since it provides proper correct control inputs in all cases. Bank angle protection provides control wheel input forces when the bank angle exceeds approximately 35 degrees; however, these can be overridden by manual inputs. Pitch envelope protection, which is not effected by the disengage bar, will provide limits to which the aircraft can be trimmed nose up or down consistent with high and low airspeed limits.

Use the autothrottle disconnect switches to disengage the autothrottles. Autothrottles may be engaged in a mode that is not correct for the situation and positive manual throttle manipulation is a more reliable course of action. **Do not** use the A/T ARM switches as this will disable the "wake up" speed protection feature of the autothrottles, which should provide correct thrust control inputs in all cases. In slow speed events, when the airspeed decreases approximately half way through the amber maneuvering band on the PFD, the autothrottles "wake up" even if previously not in use. They will automatically engage in the SPD or **THR REF** mode, advance thrust, and attempt to return the airplane to minimum maneuvering speed or the speed set in the mode control panel speed window, whichever is greater.

- **Thrust and Speedbrakes**

For APPROACH TO STALL / FULL STALL RECOVERIES set maximum thrust to aid in accelerating the aircraft back to safe flying speed.

For NOSE HIGH RECOVERIES set maximum thrust. The addition of thrust may result in a slower nose down pitch rate; however, this additional energy may be required to recover from a nose high, low airspeed, low altitude event.

For NOSE LOW RECOVERIES thrust and speedbrakes as required to achieve minimum maneuvering speed and to prevent speeds in excess of approximately 290 KIAS clean, or exceeding flap limit speed with flaps extended.

- **UNLOAD**

The key element for all recoveries is to unload the Angle of Attack (with one exception). This is accomplished by reducing back pressure on the yoke and by applying nose down elevator and stab trim as required, consistent with the specific event. In some upset situations, this may require full nose down elevator. In all events, this action will provide a significant increase in the roll authority of lateral control surfaces. The one exception to this necessity of unloading AOA is in an upright wings level, nose low, normal airspeed situation where the aircraft is not stalled. In this situation, all the lift vector force being generated is being utilized to raise the nose of the aircraft, and the recovery should begin with the "PULL" action as outlined below.

For APPROACH TO STALL RECOVERIES unload AOA by reducing back pressure on the yoke to insure the PLI is above the aircraft symbol. At low and medium altitudes, in upright, wings level conditions, this will require a pitch attitude reduction to slightly above the horizon, as contrasted to high altitude, where the pitch attitude reduction may be below the horizon. In any case, the objective to achieve an AOA that will preclude stick shaker activation and allow the aircraft to accelerate back to flying airspeed with minimum loss of altitude.

For FULL STALL RECOVERIES unload AOA by reducing back pressure on the yoke and apply nose down elevator and nose down stab trim as required to insure the PLI is above the aircraft symbol. At all altitudes in upright, wings level conditions, this will require a pitch attitude reduction to position the nose below the horizon. Altitude must be sacrificed in order to achieve an AOA that will allow the aircraft to accelerate back to flying airspeed. This AOA reduction is directly proportional to the severity of the stall. In a fully developed deep stall this will result in significant altitude loss.

For NOSE HIGH RECOVERIES unload AOA by reducing back pressure on the yoke and applying nose down elevator and nose down stab trim as required. This will aid in accomplishing any roll control inputs that are required.

For NOSE LOW RECOVERIES unload AOA by reducing back pressure on the yoke and applying nose down elevator and nose down stab trim as required. This will aid in the effectiveness of any roll control inputs that are required. For wings level, nose low, normal airspeed recoveries, **unloading of AOA is not required.**

- **ROLL**

For ALL RECOVERIES use up to full aileron input as required to accomplish the roll. ***Cautious use of rudder to aid roll control should be considered only if aileron roll control is ineffective and the airplane is not stalled.***

For APPROACH TO STALL / FULL STALL RECOVERIES roll the aircraft in the shortest direction to upright wings level.

For NOSE HIGH RECOVERIES roll the aircraft in the same direction as any existing bank. If the aircraft is upright wings level, roll the aircraft either direction. This resulting bank angle will assist the UNLOAD action in providing a nose down pitch rate without subjecting the aircraft to zero or negative G forces. The amount of desired bank angle is dependent upon the severity of the nose up pitch attitude and the airspeed trend. Normally 15 to 20 degrees angle of bank is sufficient; however, up to 90 degrees of bank may be used in extreme nose high attitudes. Then, as the nose approaches the horizon, roll to upright wings level. The roll out should be timed so as to achieve wings level with the nose slightly above the horizon, airspeed permitting. At low airspeed, it may be necessary to accept a nose low attitude to accelerate to flying airspeed.

For NOSE LOW RECOVERIES roll the aircraft in the shortest direction to upright wings level as required. If the aircraft is already wings level, **no roll input is required.**

- **PULL**

For APPROACH TO STALL / FULL STALL RECOVERIES, with the wings level, apply back pressure on the yoke after achieving flying airspeed (aircraft symbol below PLI). Adjust the pitch to avoid ground contact or obstacles. Trim as required to allow acceleration to flying airspeed. Be cautious not to apply excessive nose up elevator or nose up stab trim, which could induce a secondary stall.

For NOSE HIGH RECOVERIES, as the nose approaches the horizon and wings are being rolled level, apply back pressure and trim as required to achieve a level or slight nose high pitch attitude.

For NOSE LOW RECOVERIES, with the wings level but at a slow airspeed, apply back pressure and nose up stab trim only when the airspeed approaches the maneuvering speed for the current configuration. If at normal or high airspeed, begin the pull out immediately by applying back pressure and nose up stab trim as required. During the pull out, adjust thrust and drag to insure not exceeding approximately 290 KIAS (clean) or flap limit speed with flaps extended. During nose low events exceeding 10 degrees, the aircraft will accelerate very rapidly. Although the V_a (design maneuver speed or "corner" speed) varies with altitude, 290 KIAS serves as a suitable target limit, and this speed will result in minimum loss of altitude during the recovery.

For ALL RECOVERIES, adjust pitch and thrust to avoid ground contact or obstacles.

- **Configuration Changes**

During all recoveries, do not change gear or flap configuration until the aircraft is recovered, and all aircraft parameters are stabilized. Then cleanup or reconfigure the aircraft on schedule as required. If any event or recovery results in the exceedence of an aircraft operating limit (overspeed of flaps, gear, "G" limit, etc.), check for visible aircraft damage, abnormal flight control responses, hydraulic system status, EICAS messages and use caution during any subsequent configuration changes.

- **Pilot Monitoring (PM) Duties**

Situational awareness and confirmation of recovery progress is aided by the annunciation of **critical** aircraft performance information and trends. This may include attitude, altitude, airspeed, vertical speed and ground/obstacle proximity as appropriate throughout the event. The Pilot Monitoring (PM) should evaluate the situation, and **call out those aircraft performance parameters that are the most critical in the particular situation**. Brief, concise comments and values are the most effective way to confirm that the Flying Pilot (PF) is aware of the situation. Proximity to the ground, severity of the aircraft attitude/airspeed status, and developing performance trends should serve as the basis for the specific information to be called out. For example "50 degrees nose high, 100 knots" or "target minus 20 knots, sinking 2000" are examples that would clearly confirm the most critical information at that point in the event.

Additionally the MP will verify all required actions have been completed and call out any omissions.

APPROACH TO STALL / FULL STALL RECOVERY DUTIES

Pilot Flying (PF)	Pilot Monitoring (PM)
Assess and identify the situation using all available instrument displays	
<ul style="list-style-type: none"> • Disconnect autopilot and autothrottle. • Advance thrust levers to maximum thrust. <p>APPROACH TO STALL EVENTS:</p> <ul style="list-style-type: none"> • UNLOAD AOA by reducing back pressure on yoke to insure aircraft symbol is below PLI (at high altitudes it <i>may</i> be necessary to decrease pitch attitude below the horizon to achieve acceleration). <p>FULL STALL EVENTS:</p> <ul style="list-style-type: none"> • UNLOAD AOA by releasing back pressure on the yoke and applying nose down elevator and nose down stab trim as required to insure aircraft symbol is below PLI (at all altitudes it <i>will</i> require a decrease in pitch attitude to position nose below horizon). • ROLL in shortest direction to upright wings level. • PULL (with wings level) by applying back pressure after achieving flying airspeed (aircraft symbol below PLI). Adjust pitch to allow acceleration to speed appropriate for configuration and to avoid ground contact or obstacles. • Do not change gear or flap configuration until fully recovered. 	<ul style="list-style-type: none"> • Call out critical aircraft performance information and trends. This may include attitude, altitude, airspeed, vertical speed and ground/obstacle proximity as appropriate throughout the event. • Verify all required actions have been completed and call out any omissions.

NOSE HIGH RECOVERY (ANY BANK ANGLE) DUTIES

Pilot Flying (PF)	Pilot Monitoring (PM)
Assess and identify the situation using all available instrument displays	
<ul style="list-style-type: none"> • Disconnect autopilot and autothrottle. • Advance thrust levers to maximum thrust. • UNLOAD AOA by reducing back pressure on the yoke, applying nose down elevator and nose down stab trim as required. • ROLL to obtain a nose down pitch rate, then roll wings level as nose approaches horizon. • PULL by applying back pressure and stab trim as required to achieve a level or slightly nose high pitch attitude as nose approaches horizon. Adjust pitch to allow acceleration to speed appropriate for configuration and to avoid ground contact or obstacles. • Do not change gear or flap configuration until fully recovered. 	<ul style="list-style-type: none"> • Call out critical aircraft performance information and trends. This may include attitude, altitude, airspeed, vertical speed and ground/obstacle proximity as appropriate throughout the event. • Verify all required actions have been completed and call out any omissions.

NOSE LOW RECOVERY (ANY BANK ANGLE) DUTIES

Pilot Flying (PF)	Pilot Monitoring (PM)
Assess and identify the situation using all available instrument displays	
<ul style="list-style-type: none"> • Disconnect autopilot and autothrottle. • Thrust and speedbrakes as required to achieve minimum maneuvering speed and prevent speeds in excess of 290 KIAS clean or exceeding flap limit speed with flaps extended. • UNLOAD AOA by reducing back pressure on the yoke and applying nose down elevator and nose down stab trim as required. • If upright wings level, nose low, normal airspeed unloading of AOA is not required. • ROLL in shortest direction to upright wings level. If aircraft is already wings no roll input is required. • PULL (with wings level) by applying back pressure and stab trim as required to achieve a level or slightly nose high pitch attitude. Begin pullout at minimum maneuvering airspeed and do not to exceed 290 KIAS clean or flap limit speed with flaps extended. Adjust pitch and thrust to avoid ground contact or obstacles. • Do not change gear or flap configuration until fully recovered. 	<ul style="list-style-type: none"> • Call out critical aircraft performance information and trends. This may include attitude, altitude, airspeed, vertical speed and ground/obstacle proximity as appropriate throughout the event. • Verify all required actions have been completed and call out any omissions.

WARNING: Excessive use of pitch trim or rudder may aggravate an upset situation or may result in loss of control and/or high structural loads.

TRAINING**GENERAL**

The purpose of this section is to provide pilots with an overall view of what is expected of them during Continuing Qualification training. In order for the training periods to provide maximum value, it is critical that the systems and maneuvers for that period be reviewed in detail. It is also beneficial to thoroughly review your Jeppesen charts for the airport to be used during the event.

All simulator / FTD training events are conducted with a full crew. If necessary, an additional flight instructor will be scheduled as Captain or First Officer to insure crew based training.

For specific information, concerning the briefing subjects, maneuvers, and airports to be used for each event refer to the B777 AQP Continuing Qualification Training Bulletin for the specific year.

CONTINUING QUALIFICATION EVENTS

As a result of operational requirements and line pilot input, refinements and enhancements are continually being made to the B777 Continuing Qualification (CQ) Training Program. The program consists of the following eight events, scheduled for maximum effectiveness and continuity:

1. Continuing Qualification Simulator Training
2. Maneuvers Validation
3. Line Oriented Evaluation / Special Purpose Operational Training
4. 121-439B Landing Recency of Experience Simulator Training
5. Captain's Annual Line Check
6. Annual Systems Review
7. Global Contrails
8. General Subjects Ground School

Continuing Qualification Simulator Training (CQST)

The CQST is designed to address the proficiency issues inherent with the long-haul mission of the B777. This event is scheduled with a base month 6 months after the CQ MV/LOE base month. Early / due / grace rules apply to the scheduling for this event.

CQST is proceeded by a **2 hour briefing** and is conducted as a 4 hour period in the full flight simulator. Unlike LOFT oriented training events, this is ***training to proficiency*** conducted by the repeated accomplishment of select maneuvers. The maneuvers selected are those which are most likely subject to degradation of proficiency during the one year time frame between the annual CQ MV/LOE events. Refer to the current CQ Training Bulletin for details concerning this event.

Inability to successfully accomplish all maneuvers during the CQST period will require additional training prior to line flying.

Maneuvers Validation (MV)

The MV is the first day of the 2 day MV/LOE annual simulator training / evaluation program. The MV is scheduled with a base month the same as the Initial Training Qualification LOE, i.e. 6 months before / after the CQST base month. Early / due / grace rules apply to scheduling for this event.

The MV is proceeded by a **2 hour briefing** and ***flight manual knowledge validation***, and is conducted as a 4 hour period in the full flight simulator. The period is designed to ***train and validate*** flight manual limitations, planning / performance issues, aircraft systems, normal / non-normal procedures, checklist usage, flow patterns, pilot tactile skills, and CRM.

The MV period contains 3 **“first look maneuvers”** which change every year. These items are intentionally not reviewed during the briefing in order to determine which specific skill deteriorate over time and require additional emphasis during future training. This method is mandated by the FAA for all AQP programs and is the most accurate method available in ascertaining the probable outcome should a crew encounter such an event / maneuver during line operations. ***First look maneuvers are treated as “train to proficiency” items, thus affording multiple attempts to practice and demonstrate required proficiency.*** Refer to the current CQ Training Bulletin for details concerning this event.

Inability to successfully accomplish all maneuvers during the MV period will require additional training prior to the LOE or line flying.

Line Oriented Evaluation (LOE) And Special Purpose Operational Training (SPOT)

The LOE is the second day of the 2 day MV/LOE annual simulator training / evaluation program. The LOE is preceded by a **2 hour briefing**; one hour devoted to a review of the LOE ETOPS flight paperwork, and one hour devoted to a review of the specific SPOT training program for that particular year. The two segment LOE is based on one of 2 different B777 international flight scenarios, and is a line oriented, real time flight segment *evaluation*. It is based on typical line-encountered events and includes one major non-normal, resulting in an air turn back or diversion to an ETOPS alternate. Both of the 2 segments depart from the same international airport with the same flight paperwork and typically require approximately 3 hours total for completion. Both individual and crew performances are evaluated with respect to normal and non-normal procedures, with emphasis on FMS skills, situational awareness, judgement, crew interaction, and CRM.

The remaining one hour of this 4 hour period is devoted to the current year's SPOT training, which is *training to proficiency*. Examples of this type of training would be Meters/QFE diversions, CPDLC, or other procedural training which is important for normal line operations. *In preparation for the SPOT training please insure you have thoroughly reviewed any bulletins, videos, etc. which are distributed for this training each year.*

Both the LOE and the SPOT may be conducted in the full flight simulator or the Level 6 Flight Training Device (FTD). Refer to the current CQ Training Bulletin for details concerning this event.

Inability to successfully accomplish all the events sets of the LOE or successfully complete the SPOT training program, will require additional retraining / checking prior to line flying.

121 - 439B Landing Recency Of Experience Simulator Training

The 121-439B Landing Recency of Experience training is designed to *retain or re-establish B777 landing currency* as per the FARs.

It remains the pilot's responsibility to track their own landing currency and within 21 days of anticipated expiration of currency, to contact their base Assistant Chief Pilot and confirm that a simulator period is most likely required.

The Chief Pilot's office will then contact B777 Training Scheduling to schedule the simulator period, transportation, and hotel room as required. If the period is subsequently not required due to accomplishment of required landings or for any other reason, **it is essential you contact training scheduling as soon as possible and advise of the circumstances.**

The Landing Recency of Experience period is preceded by a 1 hour briefing and is conducted as a 2 hour for one pilot (4 hours for 2 pilots) full flight simulator period. This is considered as *training to proficiency* and allows pilots to review and practice skill sets affected by limited takeoffs and landings. In order to derive the most benefit, the pilot should review Section 3 of the B777 Flight Manual with emphasis on normal procedures, flows, and checklists for all phases of flight, including flight deck safety inspection through the termination checklist. Refer to the current CQ Training Bulletin for details concerning this event.

Inability to successfully accomplish all maneuvers during the 121-439B Landing Recency of Experience period will require additional training prior to line flying.

Captain Annual Line Check

The current Captain's Annual Line Check will continue to be required with no change to the base month. Although First Officers are not required a specific annual line check, they will be evaluated in the performance of their duties during the accomplishment of a Captains Line Check, as this evaluation is a review of the entire crew's performance.

Annual Systems Review (ASR)

The base month used for CQST also serves as the base month for accomplishment of the 4 hour self study Computer Based Training (CBT) Annual Systems Review. This module is a review of selected aircraft systems as well as current subjects. Just like simulator training, this self study CBT program ***can only be completed during the pilot's base month (early / due / and no later than the 25th of the grace month) in order to retain qualification in the aircraft.***

All aircraft systems have been divided into 4 groups (A, B, C, D) based upon system interaction, complexity, and sheer size of material to be reviewed. Refer to the **ASR SUBJECT MATTER** matrix in this section for the current year's subjects.

This course is available on the Continental CBT server available to the Bases or the Simulator building. It is identified by the respective aircraft and applicable years. It is not necessary to complete all ASR modules in a single visit. Individual modules need only be completed through the test to receive credit for the module during that session. *Although not mandatory, it is strongly recommended that all pilots complete their ASR prior to the CQST.*

Global Contrails

There are self-study **summer** and **winter Global Contrails** publications, which provide a comprehensive review of the specific year's systems not covered by the ASR CBT. Due dates for completion will be included in the publications. By alternating the coverage between CBT and Global Contrails, all systems will be covered once in 2 years and twice (once by each method) in 4 years. *A review of non-normals from the systems being covered that year will provide the foundation for many of the event sets embedded in the annual LOE.* The Global Contrails are available on the internet.

General Subjects Ground School

General Subjects Ground School is the same as the current **Day 1** and continues with no change to the base month. It is taught at all bases during the first 7 months of the year. The Continental Flight Operations Manual must be brought to this course.

ADMINISTRATIVE DETAILS

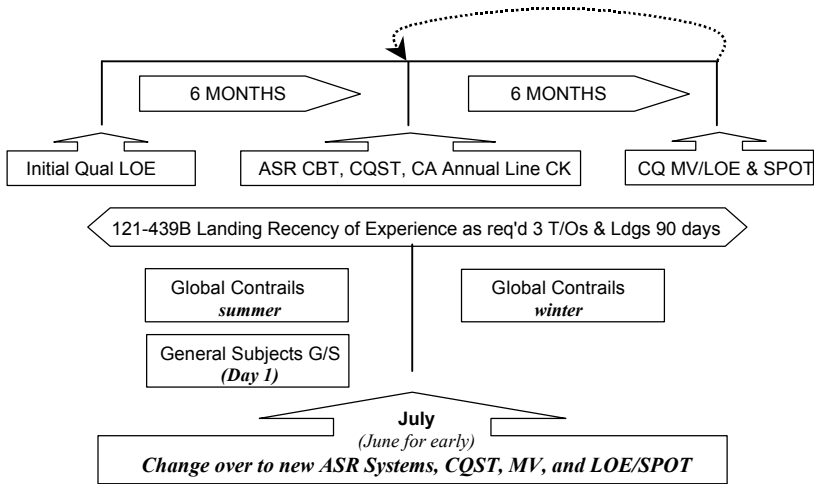
All B777 Pilots are required to bring Sections 1 thru 5 of their B777 Flight Manual, including Training Bulletins and current revisions to all simulator training events.

Pre-assembled Jeppesen B777 Trip Kits (containing all necessary charts / maps) and a current Flight Operations Manual are provided for all simulator / FTD training events. However, a detailed review of all appropriate Jepp charts should be conducted prior to the simulator event. **All appropriate sections of the B777 Flight Manual, including limitations, should be reviewed in preparation for the event.**

Every attempt is made to schedule a Captain and First Officer as a crew. This is frequently not possible but because all Continental B777 pilots are rated in the aircraft, trained in the duties of both seats, and are able to fly the aircraft from either seat (with noted Ops Manual exceptions), it is expected that all B777 pilots be familiar with the duties of both seats.

SUMMARY OF B777 CONTINUING QUALIFICATION PROGRAM

The following diagrams and profiles summarize the B777 AQP Continuing Qualification Training Program.



B777 ANNUAL SYSTEMS REVIEW (ASR) SUBJECT MATTER				
YEAR	2000 - 2001	2001 - 2002	2002 - 2003	2003 - 2004
METHOD	Group A	Group B	Group C	Group D
CBT coverage	COMMUNICATIONS HYDRAULICS LANDING GEAR WARNING SYSTEMS	AIR SYSTEMS ANTI-ICE & RAIN ENGINES & APU FIRE PROTECTION FUEL	AIRPLANE GENERAL ELECTRICAL FLIGHT CONTROLS	AUTO FLIGHT FLT INSTM DSP FLT MGT NAV
GLOBAL CONTRAILS coverage	Group C summer	Group D summer	Group A summer	Group B summer
	AIRPLANE GENERAL winter ELECTRICAL FLIGHT CONTROLS	FLT INSTM DSP FLT MGT NAV winter AUTO FLIGHT	COMMUNICATIONS WARNING SYSTEMS winter HYDRAULICS LANDING GEAR	ENGINES & APU FIRE PROTECTION winter AIR SYSTEMS ANTI-ICE & RAIN FUEL

ACCEPTABLE PERFORMANCE

Crewmembers are expected to use good judgment in the selection of configurations and speeds, and in the execution of procedures. This includes the use of other crewmembers to perform functions that would divert attention from maintaining proper aircraft control.

The aircraft should be flown with precision at all times. The following criteria are considered acceptable:

- Altitude - $\pm 100'$
- Airspeed - ± 5 knots
- Heading - $\pm 5^\circ$

During simulated non-normals, first consideration should be given to maintaining aircraft control. Be deliberate, i.e. fly the aircraft, then take care of the non-normal. Although non-normal procedures should be accomplished within a reasonable period of time, no time limit is placed on any particular item. The other crewmember should be used to the fullest extent to assist with the non-normal.

Satisfactory performance is required on each procedure and maneuver. Advanced preparation resulting in good procedural knowledge permits concentration on smooth and precise aircraft control. This enhances overall performance and makes the training a meaningful experience.

During the LOE, crews fly trip segments in real time, using the same flight papers, nav aids, and communications as they would during a line trip. Non-normal events such as emergencies, ATC, or weather problems are a part of the LOFT scenarios. The intent is for the crew to work as a team, making the best use of available resources. There is seldom one "correct" solution to these problems.

Debriefings


Plan to devote the time for a complete debriefing following all training events. The debriefing is a critical portion of training / checking and requires approximately one hour. Crewmembers will be asked to evaluate their performance, openly discussing both successes and mistakes.

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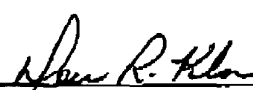
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 Principal Operations
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B777 ETOPS / LONG RANGE NAVIGATION BRIEFING GUIDE

This briefing guide contains those items that are pertinent to ETOPS and LRN operations, presented in a typical flight sequence. Some items may not be required or applicable to every flight. It is intended that this guide supplement Section 3-1.

PREFLIGHT PLANNING-DISPATCH

- ☐ CK dispatch release/redispach release (if applicable)..... C
- ☐ CK verification flight plan (if applicable) C
- ☐ Confirm the CAL and ICAO flight plans agree C
- ☐ Insure flight plan depicts appropriate MAG/TRU courses on NCA/AMU Routes (if applicable)..... C
- ☐ CK NAT date/time & LAT/LON with both flight plans..... C
- ☐ CK fuel for FLAG and ETOPS requirements C
- ☐ CK weather/NOTAMS for refile airports, ETOPS alternates, destination, destination alternates C
- ☐ Complete Plotting Chart F

FLIGHT DECK PREPARATION

- ☐ Logbook, ETOPS pre-departure, MEL, Fuel Freeze C
- ☐ Enter min. fuel temp. operational limit into FMC C F
- ☐ Check LRN kit on board C
- ☐ Load/uplink WPTs from MFP in RTE 1 F
- ☐ Load ETOPS arpts, Critical Pts, depress/escape in RTE 2..F
- ☐ Confirm ICAO (A) (B) noise abatement departure from 10-7 page to TAKEOFF 2/2..... F
- ☐ Verify WPTs with MFP C F
- ☐ Log FMC pre-departure accuracy check (<0.3 NM)..... F
- ☐ Perform HF operational reception check..... F
- ☐ Accomplish International Documents check C
- ☐ Verify PDC with MFP C

IF DELAYED DEPARTURE OR RETURN TO GATE

- ☐ Re-check ETOPS weather/NOTAMS, NAT validity, dispatch release, ETOPS pre-departure check..... C

BEFORE TAKEOFF

- ☐ Review transition altitude for departure PF PM

ENROUTE PRIOR TO COAST OUT

- ☐ Obtain oceanic clearance via radio or data-link PM
- ☐ Accomplish ADS LOGON 15 - 45 mins prior to entry into ADS airspace (as required)..... PM
- ☐ Coordinate climb clearance to assigned TRK altitude and coast out time restrictions with domestic ATC..... PF PM
- ☐ Adjust ICAO STEP as requiredPF
- ☐ Log Coast Out, Altimeter (≤ 200 ft RVSM) & Compass CKs...PM
- ☐ Enter CEEP/CEXP on FIX pages PM
- ☐ Prior to CEEP confirm ETOPS weather/NOTAMS and acknowledge with "ETOPSOK" downlink..... PM
- ☐ Prior to CEEP send Mx Verification Flt msg (if required) ...PM
- ☐ Obtain HF frequencies, do HF Selcal Check PM

ENROUTE ETOPS

- ☐ CK assigned Mach on CRZ page, LNAV / VNAV engaged ... PF PM
- ☐ Monitor 121.5 and appropriate Air-to-Air PF PM
- ☐ Set 2000 (or appropriate code) in transponder 30 min into Track PM
- ☐ Verify RTE 2 loaded correctly PF PM
- ☐ Monitor WX for redispach, ETOPS altns, destination & destination altn through datalink, HF, or VOLMET..... PM
- ☐ Configure/reconfigure ALTERNATE page as flight progressesPF
- ☐ Record mid-point MET data, if required PM

REDISPATCH PROCEDURES

- ☐ Within 2 hours of redispach point start procedures PM
- ☐ Project fuel remaining at the redispach point and relay that to the dispatcher PM
- ☐ Copy and acknowledge redispach clearance to original destination - OR -CF
- ☐ Coordinate a new clearance with ATC if diverting to the refueling airportCF
- ☐ Inform Dispatch of your intentions to proceed to original destination of alternate.....C

WAYPOINT PROCEDURES ***APPROACHING A WAYPOINT**

- ☐ Compare next WPT, M/C, DIST & TIME on FMC vs MFP. If in agreement, put single slash on MFP over the WPT, set outbound MAG HDG on MCP (set the TC from FMC LEGS page when the FMC is operating in true)PF
- ☐ Perform the FMC Position Accuracy CK (Log if required**) PM
- ☐ Display PPP on map with ETA fix reminder PM
- ☐ Compare altimeters PM

AT THE WAYPOINT

- ☐ Confirm aircraft turns to correct outbound heading and LNAV/VNAV engaged PF PM

AFTER WAYPOINT PASSAGE

- ☐ Log and compare ATA, ETA, and FUEL on MFP, place second slash over WPT on MFPPF
- ☐ Transmit/monitor POS REPORT/MET data PM PF
- ☐ Accomplish PPP/time and log on chart (if required**). Recheck accuracy of next WPT, ETA and revise if necessary PM
- ☐ Log mid point MET data on MFP as required MFP.....PF

* Captain may reverse PF vs. PM waypoint procedures duty assignments as desired provided all are completed.

** It is not necessary to log this data on the plotting chart as long as **all three** of the following conditions are met: GPS is updating the FMC, the inertial Δ value is 4.0 NM or less, and ANP is less than RNP.

COAST IN AND ARRIVAL

- ☐ Log Coast In CK (if required) PM
- ☐ Confirm domestic routing PF PM
- ☐ Confirm desired routing in RTE2 PM
- ☐ CK local transition level, speed limit points, holding procedures and program as required PF PM

TEMPERATURES (CELSIUS / FAHRENHEIT)					
°C	°F	°C	°F	°C	°F
-40	-40.0	-8	17.6	24	75.2
-39	-38.2	-7	19.4	25	77.0
-38	-36.4	-6	21.2	26	78.8
-37	-34.6	-5	23.0	27	80.6
-36	-32.8	-4	24.8	28	82.4
-35	-31.0	-3	26.6	29	84.2
-34	-29.2	-2	28.4	30	86.0
-33	-27.4	-1	30.2	31	87.8
-32	-25.6	0	32.0	32	89.6
-31	-23.8	1	33.8	33	91.4
-30	-22.0	2	35.6	34	93.2
-29	-20.2	3	37.4	35	95.0
-28	-18.4	4	39.2	36	96.8
-27	-16.6	5	41.0	37	98.6
-26	-14.8	6	42.8	38	100.4
-25	-13.0	7	44.6	39	102.2
-24	-11.2	8	46.4	40	104.0
-23	-9.4	9	48.2	41	105.8
-22	-7.6	10	50.0	42	107.6
-21	-5.8	11	51.8	43	109.4
-20	-4.0	12	53.6	44	111.2
-19	-2.2	13	55.4	45	113.0
-18	-0.4	14	57.2	46	114.8
-17	1.4	15	59.0	47	116.6
-16	3.2	16	60.8	48	118.4
-15	5.0	17	62.6	49	120.2
-14	6.8	18	64.4	50	122.0
-13	8.6	19	66.2	51	123.8
-12	10.4	20	68.0	52	125.6
-11	12.2	21	69.8	53	127.4
-10	14.0	22	71.6	54	129.2
-9	15.8	23	73.4	55	131.0

METERS to FEET		
METERS	FT / M	FEET
0.3048	1	3.2808
1	2	7
1	3	10
1	4	13
2	5	16
2	6	20
2	7	23
2	8	26
3	9	30
3	10	33
6	20	66
9	30	98
12	40	131
15	50	164
18	60	197
21	70	230
24	80	262
27	90	295
30	100	328
61	200	656
91	300	984
122	400	1312
152	500	1640
183	600	1968
213	700	2296
244	800	2625
274	900	2953
305	1000	3281

RVR EQUIVALENT	
RVR (F)	RVR (M)
300	75
400	125
500	150
600	175
700	200
1000	300
1200	350
1600	500
1800	550
2000	600
2100	650
2400	750
3000	1000
4000	1200
4500	1400
5000	1500
6000	1800

GENERAL

OVERVIEW

This section addresses Long Range Navigation (LRN). For two engine aircraft, Long Range Navigation usually means Extended Twin Engine Operations (ETOPS) over water or land in areas where no **Suitable** airports exist.

When plotting is required, ETOPS flights and LRN flights that remain non-ETOPS require implementation of many of the same procedures / verification steps. Exemptions from plotting may exist for aircraft meeting certain equipment requirements on specified routes or in specified regions (see the International Flight Operations Guide).

The ETOPS/LRN briefing guide appears at the front of this section to serve as a review of the normal ETOPS and LRN crew duties. The duties described in the briefing guide will be performed by the indicated crewmember, or that crewmember designated by the Captain. The ETOPS/LRN Briefing Guide is a resource to ensure critical tasks are accomplished. These tasks are discussed in detail in the remainder of this chapter.

The first sub-section is ETOPS/LRN Definitions.

The following sub-sections are designed to familiarize a crewmember with a typical ETOPS flight from start to finish. It is assumed that all NORMAL procedures are incorporated into the flight segment.

A 120-minute ETOPS flight from Newark (KEWR) to London, Gatwick (EGKK) is used as an example, throughout this section.

Note: Material contained in this section is aircraft specific. Information that is Continental policy or procedures may be found in the Flight Operations Manual, B777 Flight Manual, IFOG manual, and Jeppesen coverage.

DEFINITIONS

Actual Navigation Performance (ANP) – The FMC estimate of the quality of its calculated position. The ANP value is the radius of a circle centered on the FMC calculated aircraft position with a 95% probability that the actual aircraft position is within that circle.

Adequate Airport – An airport that satisfies the aircraft performance requirements applicable at the expected landing weight. These airports are listed in the Operations Specifications as authorized airports. Examples of criteria used for designation of an airport as authorized are:

- availability of the airport
- capability of ground operational assistance (ATC, Meteorological and Air Information Services Offices, Lighting)
- availability of ILS, VOR, NDB, ASR (at least one compatible navaid must be available for an instrument approach)
- airport category for rescue and fire fighting

Note: The aircraft is allowed to exceed the runway PCN (Pavement Classification Number), when the airport is used for an emergency.

Authorized Operations Area (AOA) – A term synonymous with Area of Operation. The region within which Continental is authorized to conduct extended range operations. The distance to the **Suitable** enroute alternate airport(s) from any point along the intended route must be covered within the approved time, selected by Continental Dispatch, using the single engine cruise speed (assuming still air and ISA conditions).

The Continental Airlines single engine diversion speed for the B777 is Mach .84/329 KIAS. The data is based on engine shutdown at or near the optimum altitude for typical weights and is conservative for driftdown from any higher altitude. Increased gross weights will have little effect in distance, but will affect engine inoperative altitude capability. Fuel jettison may be appropriate depending upon the circumstances.

The maximum diversion distance used to establish the Area of Operations is obtained from the following chart. Credit is taken for the increased true airspeed that results from the driftdown occurring during the first 60 minutes of the flight after engine failure. This results in a 453 NM distance during the first 60 minutes, a 433 NM distance for the second 60 minutes, and a 434 NM distance for the third 60 minutes due to continued fuel burn.

AOA DIVERSION TIME/DISTANCE

- B777 -224 IGW
- GE90-90B POWER
- 1 ENGINE INOP (WINDMILLING)
- MAX CONTINUOUS THRUST ON REMAINING ENGINE
- .84M/329 KIAS SPEED
- 460,000 LBS GROSS WEIGHT

TIME in MINUTES	60	75	90	120	138	180	207
DISTANCE in NM	453	561	670	886	1016	1320	1516

Note: Continental Airlines is authorized to dispatch the B777 aircraft under 207 minute ETOPS authority for operations that traverse or enter the North Pacific (NOPAC) area of operation. For 207 minute ETOPS the NOPAC area is defined by the Anchorage and Tokyo FIR extending 100 miles south of the southern most NOPAC route. The northern boundary of the NOPAC area is defined by the northern boundaries of the Anchorage and Tokyo FIRs.

C-EEP (Computer generated ETOPS Entry Point) – The point on the outbound route that is one hour flying time at the approved single-engine diversion speed (under standard conditions in still air) from an Adequate airport. C-EEP is identified on the flight plan under ETOPS ANALYSIS.

C-EXP (Computer generated ETOPS eXit Point) – The point on the inbound route that is one hour flying time at the approved single-engine diversion speed (under standard conditions in still air) from an Adequate airport. C-EXP is identified on the flight plan under ETOPS ANALYSIS.

Chronic Write Up – Three or more logbook discrepancies on the same ETOPS Critical System within a ten-day period. A chronic write up requires a verification flight prior to ETOPS entry.

Critical Point (CP) – A point on the intended route where the one-engine inoperative diversion time from the two closest ETOPS alternates is equal. It is based on one engine inoperative performance, and assumes unpressurized flight at 10,000 feet using forecast winds and OAT's at 10,000 feet. It is shown as CRITICAL POINT (a LAT/LON coordinate) in the ETOPS ANALYSIS section of the flight plan.

ETOPS (Extended Range Twin Engine Operations) – A term used to describe extended range (ER) flights in twin-engine aircraft. Refers to those flights conducted over routes that contain a point further than one hour flying time from an Adequate airport at the approved one engine inoperative diversion speed under standard conditions in still air. The MEL uses “ER” to refer to ETOPS specific requirements / limitations.

ETOPS Alternate – **Suitable** airports assigned to an ETOPS flight and listed in the Flight Release and ETOPS ANALYSIS section of the paperwork.

ETOPS Alternate Suitability Time Calculations – The **beginning** of the ETOPS alternate suitability time period found in the ETOPS analysis section of the flight plan is calculated by subtracting 1 hour from the ETOPS alternate ETA, assuming a **2 engine diversion** from the C-EEP direct to the alternate at 10,000 ft. (earliest estimated arrival time). This **does** take into consideration the forecast winds and assumes no holding or additional time for an approach. The **ending** of the ETOPS alternate suitability time period is calculated by adding 1 hour to the ETOPS alternate ETA, assuming a **1 engine diversion** from the Critical Point direct to the alternate at 10,000 ft. (latest estimated arrival time). This **does** take into consideration the forecast winds and assumes no holding or additional time for an approach.

ETOPS Dispatch – Occurs at the moment the PIC signs the dispatch release agreeing that the present known conditions merit a safe release of that flight at that time.

ETOPS Reliability Program – To comply with FAR requirements for Extended Range Operations. The Reliability Program is designed to monitor performance over and above that required for normal operations. This program is “event orientated,” and requires reporting significant events detrimental to ETOPS flights within 72 hours after their occurrence. Any unusual event such as an engine shutdown, diversions (for any reason), abnormal performance by engines or aircraft systems, etc. should be reported immediately by a Captains Irregularity Report, and a maintenance logbook entry if required.

ETOPS Segment – The portion of the flight that is more than one hour flying time (approximately 453 NM at single engine diversion speed in still air) from an Adequate airport.

Eurocontrol Basic RNAV (BRNAV) – RNAV with an accuracy that meets RNP-5 for IFR operations in European airspace designated BRNAV/RNP-5. Continental Airlines ETOPS aircraft are BRNAV capable and certified.

In-Flight Shutdown (IFSD) – When an engine ceases to function in-flight and is **shutdown**, whether self-induced, crew-initiated, or caused by some other external influence.

Long Range Navigation (LRN) – Flight outside of the operational service range of ICAO standard nav aids. Navigation is dependent upon systems other than VOR/DME/ADF such as FMC/IRS/GPS. LRN flights may be either ETOPS or non-ETOPS, based on Adequate airport proximity as per the ETOPS definition.

Maximum Diversion Distance – The distance defined by the Authorized Operations Area, using the one engine inoperative speed at the maximum diversion time.

Maximum Diversion Time – The longest time approved for an airline's ETOPS Authorized Operations Area. The maximum diversion times are 75, 90, 120, 138, 180, and 207 minutes at the one-engine inoperative diversion speed of M.84/329 KIAS for the B777. The specific time used is dependent upon a number of factors including flight plan efficiency (not having to carry extra ETOPS add fuel for longer diversion time), MEL restrictions, availability of **Suitable** airports, and company / fleet authorized times.

Minimum Navigation Performance Standards (MNPS) Airspace – Designated airspace that requires specific navigation equipment to maintain a defined lateral navigational accuracy. For the specific area of application see the appropriate Jeppesen Orientation Chart. Unrestricted operations in the MNPS airspace requires the aircraft to be properly equipped and the flight crews to be familiar with MNPS navigational contingencies.

Non-ETOPS Segment – The portion of the flight that is less than one hour flying time (453 NM single engine, still air) from an Adequate airport.

Reduced Vertical Separation Minimums (RVSM) – Refers to the use of 1000 foot vertical separation. RVSM airspace is restricted to operators that are RVSM capable and certified. Continental Airlines Boeing aircraft are RVSM capable and certified.

Required Navigation Performance (RNP) – A statement of navigation accuracy necessary for operation within a defined airspace. Required navigation performance (RNP) values have been created and published for certain areas around the world. Operations in these areas require navigation systems that alert the crew if RNP is exceeded. The FMC supplies default RNP values for takeoff, en route, oceanic / remote, terminal, and approach phases of flight. The crew may enter an RNP value when required. The RNP value is shown on POS REF page 2/3. If the ACTUAL navigation performance exceeds the RNP the FMC displays the message **NAV UNABLE RNP**.

Suitable Airport – An **Adequate** airport with weather reports, forecasts, or any combination thereof, indicating the weather is at or above ETOPS alternate weather minimums. Additionally, the field condition reports (NOTAMS and associated information) indicate that a safe landing may be accomplished from one hour prior to the earliest estimated arrival time to one hour after the latest estimated arrival time.

Verification Flight – A flight that must be performed on the aircraft in order to verify its ability to conduct an ETOPS flight.

Verification Item – Those ETOPS Critical System logbook discrepancies or maintenance actions that require a verification flight to validate they are operational for the planned ETOPS segment of the flight.

CREW PROCEDURES

Reporting for Duty

Many potential problems can be discovered and eliminated prior to leaving the weather room. Plan to arrive at the weather room with sufficient time for thorough flight planning and preparation.

Aircraft Crew Complement

The normal crew complement for the B777 is two. Depending upon the flight duration, additional IROs may be assigned. All IRO duties and responsibilities are at the direction of the Captain. The Captain shall specify IRO duties for each flight segment.

The IRO(s) shall attend all preflight planning activities in the weather room.

The IRO(s) will be present on the flight deck for preflight through takeoff, climb to initial level off, and decent through parking. For exceptions see the Continental Airlines Flight Operations Manual, Operations Requiring IRO(s).

Any qualified flight crewmember may takeoff or land the aircraft at the Captain's discretion.

The Captain shall at a minimum, occupy the left seat during preflight, engine start, taxi, takeoff, and until level off at initial cruise altitude. Additionally, the Captain shall occupy the left seat no later than 30 minutes prior to "top of descent" through the descent, approach, landing, taxi and parking.

Note: The Captain, if absent from the flight deck, shall be immediately informed should any significant event or aircraft malfunction occur.

Note: For a complete and detailed description of operations requiring IRO(s) refer to the Continental Airlines Flight Operations Manual, Operations Requiring IRO(s).

Flight Deck Discipline

Aircraft control, traffic surveillance, and navigation are the principal priorities while flying in high-density traffic areas.

With an augmented crew, pilots will be changing seats throughout the flight.

PF / PM duties normally remain with the seat.

Crewmembers should change duty stations only after reaching top of climb, and should be at their duty stations prior to reaching top of descent. The pilot going off duty will brief the replacement pilot regarding items such as weather, frequency changes, or ATC requirements, etc.

Note: Above FL250, if the Captain or First Officer leaves the controls of the aircraft temporarily, the pilot crewmember remaining must put on and use their oxygen mask.

The PM should normally handle radio communications. The IRO may be assigned communications duties, and should be utilized in monitoring and recording oceanic clearances, etc.

PREFLIGHT PLANNING - DISPATCH

PLANNING OVERVIEW

Crew Coordination During Flight Planning

The flight planning process is a crew function requiring joint participation by each crewmember as specified. On an exception basis, the Captain may find it necessary to alter the crewmember functions in order to accommodate a unique operational contingency. The Captain will ensure the crew is knowledgeable of all pertinent items such as critical points, optional flight level, optional route, escape routes, NOTAMS, and weather at the destination, destination alternate, and ETOPS alternates. This is normally accomplished by reviewing the ETOPS/LRN Briefing Guide predeparture items with the **entire flight deck crew** while in the weather room.

Flight Paperwork

The Captain will confirm receipt of the following:

- Dispatch Release
- Verification Flight Plan / Dispatch Release (if required)
- Special Crew Messages
- ATC Flight Plan / ICAO Strip
- NOTAMS
- NAT Message (if required)
- Continental and ICAO Flight Plan
- Weather Package
- Plotting Chart
- Flight Envelope (if required)
- General Declaration

Plotting charts, briefing guides, flight envelopes, etc. are located in the station weather room area. It is recommended that all crewmembers carry spare plotting charts for all scheduled routes for the B777.

PREFLIGHT PLANNING

Some features of ETOPS flight paperwork are different from domestic paperwork. Following are explanations of the features unique to ETOPS. Items common to domestic flights are not addressed.

International Dispatch Release

The International Dispatch Release covers the flight, through all intermediate stops, to the final destination. However, any maintenance action requiring an MEL placard requires an amended or new release. **A delay of any nature requires a review of the valid times of the NAT message, ETOPS alternate weather, and NOTAMS.**

Example:

FLT 28/15		DISPATCH RELEASE IFR						
TYP/EQP	FROM	TO	AT1	AT2	PAY- LOAD	BURN	MINIMUM FUEL	GATE FUEL
777	005	EWR	LGW	LHR	800	882	107400	113900
FM: 57/CDG/1555		TO: 5/IAH/1100		M1	A0	F1	E0 D14	

SUBJECT TO THE FOLLOWING CONDITIONS:
 ETOPS FLIGHT - MAXIMUM DIVERSION TIME LIMITED TO 120 MINUTES
 FROM A SUITABLE AIRPORT
 ETOPS ALTERNATES CYQX/YQX BIKF/KEF EINN/SNN
 POTENTIAL LGT TURBULENCE INDICATED FROM 35W-30W FL320-360
 CAPT DISP: LARRY GRINSTEAD
 F/O S/O TEL* 713-324-7560
 SPD* 928

-SPECIAL AIRPORTS- TO OPERATE TO OR FROM THESE AIRPORTS:
 *** LGW LHR ***

DESTINATION IS A FAA OR CONTINENTAL DESIGNATED SPECIAL
 AIRPORT AND/OR IS LOCATED IN A REGION THAT CONTINENTAL
 REQUIRES CREWS TO COMPLETE AREA QUALIFICATIONS. REVIEW
 FLIGHT OPERATIONS MANUAL, SECTION 5, FOR CREW ENTRY
 REQUIREMENTS
 REQUIRES CREWS TO COMPLETE AREA QUALIFICATIONS REVIEW
 FLIGHT OPERATIONS MANUAL, SECTION 5, FOR CREW ENTRY
 REQUIREMENTS

A/C 0005 CO GRH OEW 00322539 IDX 109.4 SEL-CAL EHGR
 AIRCRAFT RVSM CERTIFIED -- COMPLIES BRNAV/RNP
AIRCRAFT CAT III/LAND 3.....
 ===== AIRCRAFT PLACARDS =====+

Review the SUBJECT TO THE FOLLOWING CONDITIONS section for the following information:

- The statement ETOPS FLIGHT.
- The Maximum Diversion Time.
- The ETOPS Alternates.
- Verification flight information and non-ETOPS option (if required).
- Redispach information (if required).
- MEL placards that impact the ETOPS diversion time (if applicable).
- Status of RVSM and CAT II/III.

The following information is located after SPECIAL CREW MESSAGES:

- The NAT message, if a NAT track is to be flown.
- Weather for the **Suitable** airport(s), refuel airport (if required), destination, and destination alternate(s).

Verification Flight

To clear an item, maintenance may request crew comments on a repaired or modified aircraft system. This may be done on any trip segment and the terminology will be "Verification Flight." Maintenance Control is responsible for notifying dispatch of this requirement.

The crew should be briefed prior to dispatch concerning the maintenance performed that necessitates the verification flight. As a result, the release contains the remarks "CAPTAIN – CALL DISPATCH". Once contacted, the Dispatcher will conference in maintenance for the briefing. The briefing should convey to the crew the specific actions required during the verification, as well as the method to be used to properly record the satisfactory completion of the verification flight. A placard on the cover of the logbook advises the crew of the system required for comment.

A verification flight may be conducted on any non-revenue flight, non-ETOPS flight, or ETOPS flight.

On an ETOPS flight, the verification phase must be documented as satisfactorily completed prior to reaching the ETOPS entry point. If the verification flight is unsuccessful, the aircraft must fly a non-ETOPS route to destination or return to the departure airport. A second release and flight plan for the non-ETOPS route plus additional fuel must be acquired. In effect, the crew is dispatched with two flight plans. The flight plan the crew flies depends on the results of the ETOPS critical (ER) item(s) verification. In effect, the crew is verifying that all ETOPS Critical System discrepancies, open issues, have been corrected prior to entry into ETOPS. If the Dispatcher desires the flight to return to the departure airport, in the event of an unsuccessful verification flight, he/she will so state in the release.

Note: In the event of a diversion or irregular operations where ETOPS qualified maintenance personnel are not available, Maintenance Control may release the aircraft in accordance with GMM 07-03-03. Under this provision, a verification flight is required for the first 60 minutes of the subsequent flight.

The success or failure of the verification flight is noted in the aircraft logbook, in addition to any discrepancies. Additionally, the Captain will notify SOCC and Maintenance Control with the results of the verification flight.

Example:

		DISPATCH RELEASE		IFR				
TYP/EQP	FROM	TO	AT1	AT2	PAY-LOAD	BURN	MINIMUM FUEL	GATE FUEL
777 016	IAH	IAH	SAT		10	80	29700	47000
FM: 50/IAH/0		TO: NO ROUTING				M1	A0	F0 E2

SUBJECT TO THE FOLLOWING CONDITIONS
 NOTE: ETOPS MAINTENANCE VERIFICATION FLIGHT
 REQUEST PHONE CALL TO DISPATCH TO CONFER WITH MTNCE
 RC6411/

REMARKS: *CAPTAIN - CALL DISPATCHER*

CAPT	DISP: JEFFREY DEVORE
F/O	TEL* 713-324-7500
S/O	SPD* 920

===== AIRCRAFT PLACARDS =====
 06-04 79-ETOPS ETOPS VERIFICATION FLT, +1 ENG OPS
 A/C 0016 CO GRH OEW 00321971 IDX 110.8 SEL-CAL AMEP
 AIRCRAFT RVSM CERTIFIED -- COMPLIES BRNAV/RNP
 IF HAVING OCD PROBLEMS - REVERT TO VOICE PROCEDURES
AIRCRAFT CAT III/LAND 3.....

Extended Range MEL Items

System redundancy levels appropriate to Extended Range operations are reflected in the MEL. They are identified by the code “ER.” ER items also have a NOTIFICATION TO DISPATCH REQUIRED statement in column 5 of the MEL.

Non-ETOPS Flight

There are occasions when the flight would normally dispatch using ETOPS, but circumstances (maintenance, MEL items, weather, etc.), prevent the flight from operating ETOPS. When this occurs, the crew should check the Jeppesen charts to verify the route selected remains non-ETOPS.

Following are a few examples:

- When dispatched on a non-ETOPS LRN flight (such as from Newark to San Juan in the Western Atlantic).
- An unsuccessful verification flight, or an MEL item restricts the flight to non-ETOPS.
- Weather precludes the selection of **Suitable** alternates for the intended route.

There are no enroute alternate weather requirements for a non-ETOPS flight. As always, the Captain and the Dispatcher are responsible to determine the acceptability of enroute weather, and implement the best options available.

Flight Plan

Continental Flight Plan

The Continental ETOPS flight plan is similar to a domestic flight plan with the addition of the ETOPS ANALYSIS section, additional information in the FUEL CATEGORIES, and Enroute fuel temperature analysis information.

Redispatch Flight Plan

On flights requiring maximum fuel loads, a redispatch procedure may be used. The procedure allows a proportional reduction in the 10% Flag Reserve Fuel requirement, thus affording additional payload capability or reduced fuel burn. A Redispatch Flight Plan releases the flight to an INITIAL DESTINATION where normal fuel reserves can be met, with the intent of continuing the flight at the REFILE POINT to the planned FINAL DESTINATION. Upon reaching the REFILE POINT, provided the fuel is sufficient relative to the destination weather, the flight is redispatched to the FINAL DESTINATION.

It is important to understand that the flight is filed for the complete route from the departure airport to the FINAL DESTINATION. ATC is not aware of the INITIAL DESTINATION or the redispatch procedure.

Approximately one hour prior to the REFILE POINT, the flight should receive and acknowledge receipt of a redispatch message. If the redispatch message is not received one hour prior to the REFILE POINT, the Captain should initiate contact with Dispatch to ensure receipt of the message prior to the planned REFILE POINT. This message contains additional information regarding weather, ground facilities, and other items considered in the original release. Dispatch initiates the redispatch procedure using one of the following methods:

- ACARS / Data link / SATCOM
- Phone patch through ARINC
- Company VHF
- A Teletype to the controlling agency for relay to the crew.

Refer to the Flight Operations Manual for a detailed description of the redispatch procedures and additional information.

Example:

*****REDISPATCH DISPATCH RELEASE IFR*****
 INITIAL DESTINATION
 TYP/EQP FROM TO AT1 AT2 PAY- BURN MINIMUM GATE
 LOAD FUEL FUEL
 777 005 EWR PEK SHA 420 1967 250500 252300
 FINAL DESTINATION MINIMUM FUEL REQUIRED
 DOMOR HKG MFM 596 74500
 REDISPATCH IS REQUIRED BEFORE PROCEEDING PAST
 REFUEL POINT OF DOMOR
 TOTAL B/O EWR -HKG 230500
 FM: 0 TO: NO ROUTING M1 A0 F0 E1

SUBJECT TO THE FOLLOWING CONDITIONS
 ETOPS FLT/MAXIMUM DIVERSION TIME LIMITED
 TO 180 MINUTES FROM A SUITABLE ALTERNATE.
 ETOPS ALTS YUL YFB LYR YKS PEK
 RC9332/
 CAPT DISP: T SCHOLZE
 F/O S/O TEL* 713-324-7515
 SPD* 915

-SPECIAL AIRPORTS- TO OPERATE TO OR FROM THESE AIRPORTS:

*****HKG MFM*****
 DESTINATION IS A FAA OR CONTINENTAL DESIGNATED SPECIAL
 AIRPORT AND/OR IS LOCATED IN A REGION THAT CONTINENTAL
 REQUIRES CREWS TO COMPLETE AREA QUALIFICATIONS REVIEW
 FLIGHT OPERATIONS MANUAL, SECTION 5, FOR CREW ENTRY
 REQUIREMENTS

CO 99/13 EWR /HKG -KEWR/VHHH/
 REFUEL FLT 99 ORG DOMOR /DEST ZBAA RC 9332 PLAN 0161

	FUEL	TIME	DIST	FUEL	TIME	DIST
KEWR TO DOMOR	1709	10.30	5185	DOMOR -VHHH	0596	04.49 2238
DOMOR TO ZBAA	0258	02.14	1096	ALTN/VMMC	0030	00.06 0020
ALTN/ZSSS	0185	01.23	0614	RESERVE 10 PCT	0062	00.29
RESERVE 10 PERCENT	0163	01.16		RESERVE 30 MIN	0057	00.30
RESERVE 30 MIN	0059	00.30		REQUIRED	0745	
REQUIRED	2374					

1. PLANNED FUEL AT REDISPATCH POINT. 0796
2. FUEL REQUIRED AT REDISPATCH POINT WITH ALTERNATE. 0745
3. FUEL REQUIRED AT REDISPATCH POINT IF DESTINATION
 WX FCST 2000-3 OR BETTER AND ALTERNATE IS DELETED 0715

WARNING: LANDING WT. EXCEEDED AT RE-CLEAR DESTINATION BY 0000
 ZBAA ELGW 4184/MLGW 4600 ACFT WT. AT RECLEAR PT. DOMOR 4442
 DOMOR.A91W.CS.A91.UDA.A575.ERE.B458.ZN.A596.KM.KM1A.ZBAA

ICAO Flight Plan

The crew is required to possess a copy of the filed ICAO Flight Plan on all flights entering international airspace.

The Captain confirms the ICAO flight plan is valid, noting the Date/Time, Flight #, and A/C #. Ensure the date of the ICAO flight plan matches the Continental flight plan. The Continental flight plan routing and the ICAO routing must be compared to the waypoints in the body of the Continental flight plan. Any discrepancies between these 3 routings must be resolved. Subsequently, when received, the PDC or ATC clearance must be crosschecked and any differences from the flight plan verses cleared route must be resolved.

The following is an example of a B777 ICAO Flight Plan:

*****ATC FLIGHT PLAN*****

- ① (FPL-COA28-IS
- ② -B772/H-SHGXYRJ/S
- ③ -KEWR2355
- ④ -N0503F330 DCT MERIT DCT HFD DCT PUT DCT BOS DCT TUSKY N91B
CYMON/M084F370 NATY LIMRI DOLIP/N0488F370 UN523 CRK UR37
EXMOR UR14 GIBSO WILL1D
- ⑤ -EGKK0609 EGLL
- ⑥ -EET/CZQM0048 CZQX0131 CYMON0159 51N050W0223 52N040W0307
EGGX0351 52N020W0432 EISN0453 EGTT0528 REG/N78005 SEL/EHGR
RALT/CYQX BIKF EINN
- ⑦ DAT/VS COM/TCAS RMK/ADS AGCS 02.Y360 03.X370)

Explanation:

① (FPL-COA28-IS

“Filed Flight Plan,” COA is the registration for Continental Airlines, followed by the flight number. IS is a code representing the rules under which the flight will be operated. I = IFR and the type of flight, S = scheduled air carrier.

② -B772/H-SHGXYRJ/S

The 2 represents a -200 series, H= Heavy. SHGXYRJ/S designates the radio communication, navigation, and transponder code equipment.

- S = standard equipment for the route of flight
- H = HF radio
- G = Global Navigation Satellite System
- X = Other equipment
- W = RVSM
- Y = 8.33 kHz Europe
- R = RNP
- J = Datalink
- /S = transponder mode S, including both pressure-altitude and aircraft identification transmission.

③ -KEWR2355

The departure airport and the scheduled departure time in Zulu.

④ -N0503F330 DCT MERIT DCT HFD DCT PUT DCT BOS DCT TUSKY N91B
CYMON/M084F370 NATY LIMRI DOLIP/N0488F370 UN523 CRK UR37
EXMOR UR14 GIBSO WILL1D

The first subdivision -N0503F330 DCT MERIT through BOS refers to the segment of the flight operated under domestic ATC. Domestic segments must be filed in the format TAS followed by flight level. The “N” stands for knots, 0503 is the filed TAS and F330 the filed flight level. BOS is the point where the domestic portion of the route terminates.

DCT TUSKY is flown in Canadian airspace. N91B is a pre-defined North American Route found in Jeppesen Enroute – North American Routes for North Atlantic Traffic. This page shows Eastbound Routes – Common Portion, which is a direct route from TUSKY to CYMON.

The subdivision CYMON/M084F370 NATY LIMRI is the oceanic portion of the route, which must be filed with Mach number and flight level. NATY is the approved ICAO coding for the route. The /, in this case, represents a point on the route where a change in speed or altitude is planned.

Note: An ATC clearance “Cleared as filed” does not constitute authority to step climb on NATY. This / mark merely alerts ATC that a change may be requested.

LIMRI is located at the Shannon FIR where radar contact is normally established, then direct to DOLIP, (last waypoint on NAT track Y). From DOLIP, Airway UN523 to CRK, Airway UR37 to EXMOR, then UR14 to GIBSO. GIBSO represents the first point on the Willo One Delta (WILL1D) arrival into London Gatwick.

Note: This routing is a combination of the “Preferred Routes” through the Shannon and London UTAs. Though automatically filed by dispatch, it is important to realize the source of this routing. Information on Preferred Routes, if available, is found in the Jeppesen Enroute section. In the event of a track change it is incumbent upon the crew to verify the routing from end of track to destination.

⑤ -EGKK0609 EGLL

The destination airport (EGKK = London, Gatwick) and the elapsed time of flight (6 hours 09 minutes) EGLL (ICAO identification for London Heathrow) indicates the alternate if alternates are specified.

⑥ -EET/CZQM0048 CZQX0131 CYMON0159 51N050W0223 52N040W0307
EGGX0351 52N020W0432 EISN0453 EGT0528 REG/N78005 SEL/EHGR
RALT/CYQX BIKF EINN

Enroute estimates to the domestic FIR (Flight Information Region) boundary and the Canadian FIR boundary. In this example, the flight is estimated to cross CZQM 48 minutes after takeoff, and arrive at CZQX 1 hours and 31 minutes after takeoff.

REG denotes aircraft registration number N78005. SELCAL code EHGR. RALT/ (enroute alternates) CYQX BIKE EINN are listed by their 4-letter ICAO identifier.

⑦ DAT/VS COM/TCAS RMK/ADS AGCS 02.Y360 03.X370)

DAT/VS denotes Datalink/VHF, and SATCOM; COM/TCAS denotes the aircraft is TCAS equipped; REMARKS/ADS Automatic Dependant Surveillance equipment; AGCS Air Ground Communication System. Should our first choice NAT track and altitude not be available, 02.Y360 indicates NAT Y at FL 360 is our second choice, and 03.X370 identifies NAT track X at FL 370 as our third choice.

NAT Tracks

To accommodate the large volume of traffic between North America and Europe and provide efficient use of variable winds, a shifting or variable route system is utilized in the North Atlantic. This is called the North Atlantic (NAT) track system. The NAT tracks are evaluated and then published every twelve hours at approximately 0100 and 1300Z. Either the morning or afternoon Track Message will be issued to each flight as determined by the time the flight would cross Longitude 30W. This message includes all necessary details, such as a track designator for each route (U, V, W, X, etc.), the east or westbound flight levels that apply, the coordinates of each fix, the time frame during which the message is valid, and the identification of any applicable gateways or domestic routings.

NAT Track Message

For North Atlantic crossings the Captain must confirm that the North Atlantic (NAT) track routing agrees with the ICAO strip and Continental Flight Plan routing. The date of the NAT message must also be checked in relation to the planned time to cross 30° West Longitude.

The following is an example of a NAT track message:

- NAT-1/2 TRACKS FLS 320/400 INCLUSIVE
- ① AUG 16/0100Z TO AUG 16/0800Z
PART ONE OF TWO PARTS
- U STEAM OYSTR 55/50 56/40 56/30 56/20 MIMKU MAC
EAST LVLS 320 330 340 350 360 370 380 390 400
WEST LVLS NIL
EUR RTS WEST NIL
NAR N153C N155A-
- V REDBY CARPE 54/50 55/40 55/30 55/20 NIBOG TADEX
EAST LVLS 320 330 340 350 360 370 380 390 400
WEST LVLS NIL
EUR RTS WEST NIL
NAR N137B N141B-
- W YAY 53/50 54/40 54/30 54/20 DOGAL BABAN
EAST LVLS 320 330 340 350 360 370 380 390 400
WEST LVLS NIL
EUR RTS WEST NIL
NAR N123A N129B-
- X DOTTY 52/50 53/40 53/30 53/20 MALOT BURAK
EAST LVLS 320 330 340 350 360 370 380 390 400
WEST LVLS NIL
NAR N107B N113B-
- ② Y CYMON 51/50 52/40 52/30 52/20 LIMRI DOLIP
- ③ EAST LVLS 320 330 340 350 360 370 380 390 400
- ④ WEST LVLS NIL
EUR RTS WEST NIL
- ⑤ NAR N91B N97B-
- Z LUNNI 32/50 39/40 44/30 47/20 BEDRA GUNSO
EAST LVLS 310 340 360 380
WEST LVLS NIL
EUR RTS WEST NIL
NAR NIL-
END OF PART ONE OF TWO PARTS)
- ⑥ REMARKS:
1. CLEARANCE DELIVERY FREQUENCY ASSIGNMENTS FOR AIRCRAFT OPERATING FROM MOATT TO BOBTU INCLUSIVE
MOATT - SCROD 128.7
OYSTR - YAY 135.45
DOTTY - CYMON 135.05
YQX - YYT 128.45
COLOR - BOBTU 119.42
 2. TRACK MESSAGE IDENTIFICATION 228.
 3. MNPS AIRSPACE EXTENDS FROM FL285 TO FL420. OPERATORS ARE REMINDED THAT MNPS APPROVAL IS REQUIRED TO FLY IN THIS AIRSPACE. IN ADDITION; RVSM APPROVAL IS REQUIRED TO FLY WITHIN THE NAT REGIONS BETWEEN FL290 AND FL410 INCLUSIVE. REFER TO INTERNATIONAL NOTAM CYA0080/02.
 4. 80 PERCENT OF GROSS NAVIGATIONAL ERRORS RESULT FROM POOR COCKPIT PROCEDURES. ALWAYS CARRY OUT PROPER WAYPOINT CHECKS.
 5. NAT EASTBOUND SCENARIO 2 IN FORCE. SEE CFMU A.I.M. FOR ROUTING DETAILS. REFER TO EGTT A1098/02 OR EGTT G0194/02 AND EGGX G0149/02.
 6. OPERATORS ARE REMINDED OF NOTAM CYA1535/02 FOR FLIGHTS ENTERING THE NAT REGION FROM THE MONTREAL FIR/CTA.

Explanation:

- ① AUG 16/0100Z TO AUG 16/0800Z
Date and valid time.
- ② Y CYMON 51/50 52/40 52/30 52/20 LIMRI DOLIP
Y - Track Y
CYMON - Applicable gateway
51/50 52/40 52/30 52/20 LIMRI - Fix coordinates and track exit point.
DOLIP - Preferred oceanic feeder fix for entry into UK airspace. (See Jeppesen ENROUTE Section, Preferred Routes, Eastbound.)
- ③ EAST LVLS 320 330 340 350 360 370 380 390 400
Flight levels in use.
- ④ WEST LVLS NIL
Westbound flight levels not in use.
- ⑥ NAR N91B N97B-
NAR routes N91B & N97B applicable to Track Y. (See Jeppesen Enroute pages, North American Routes, Eastbound & Common Portion.)
- ⑥ REMARKS:
Contains frequencies, TMI, NOTAMS, and other information. Gander clearance delivery frequencies listed.

The Track Message Indicator (TMI) number 228 is the Julian date (16 August is the 228th day of the Julian calendar).

Note: Use of this number when requesting oceanic clearance precludes the requirement to read back track coordinates. This procedure applies to both eastbound and westbound flights operating entirely within the track structure. This procedure does not apply to random route flights.

Any NAT NOTAMS applicable to the flight will appear in the REMARKS Section of the Flight Plan.

Datum Line Technique

The NAT message may contain a note in the REMARKS that reads, "DATUM TRACK VICTOR" or "DATUM 45 NORTH." This means that on random tracks, which lie on or north of the Datum Track or Line, flight levels may be used that are not appropriate to the direction of flight.

Pacific Route Structure

General

The bulk of oceanic traffic flows over a complex and varied Pacific route system. A number of routes connect the continental U.S. and Hawaii with the Pacific Rim, including Japan, the Philippines, Australia, and New Zealand. The most northerly routes are grouped in the North Pacific (NOPAC) Route System. The Pacific Organized Track System (PACOTS) provides fuel-efficient routes for long distance transpacific flights, and are adjusted every 12 hours in response to upper level wind conditions.

NOPAC Route System

The NOPAC route system is comprised of five Air Traffic Service (ATS) routes that transit the North Pacific between Alaska and Japan. The two northern routes (R220, R580) are used for westbound traffic. The three southern routes (A451, R591 and G344) are used primarily for eastbound traffic. R591 or G344 may be used for westbound aircraft crossing the Tokyo/Anchorage FIR between 0000Z and 0600Z.

Aircraft cannot always be accommodated on their flight planned NOPAC route. In an effort to reduce coordination time and error between ATC and flight crews, the most commonly issued reroutes are provided on the Pacific Ocean 1 P (H) Enroute Chart. These reroutes will be issued by name. PHASEOLOGY – CLEARED TO (Destination) VIA (Fix) NOPAC REROUTES 1.

Example: NOPAC REROUTE 1 – R220 NANAC OTR10 CVC RJAA.

Flight crews may read back the revised clearance by name. In the event the flight crew does not have a copy of the reroute, ATC will issue a full route clearance. Any changes to the routing will necessitate a full route clearance. Named reroutes are provided to reduce pilot / controller coordination only.

Pacific Organized Track System (PACOTS)

The Pacific Organized Track System (PACOTS) was developed utilizing ATC system user and provider input. This system was designed to improve airspace utilization while providing the most efficient routes. Improvements in the accuracy of forecast winds aloft and the necessity to allow more aircraft to operate closer to their minimum time routing, resulted in the evolution of the Pacific Organized Track System. Routes between the city pairs involved change daily in response to changing wind patterns, military activity, severe weather or any other necessities.

From the perspective of the pilot, operation of the PACOTS is virtually transparent. In some cases, the rules may permit a Dispatcher to plan a flight to join or depart a PACOTS route part way along its length. Aside from those occasions, the Dispatcher must file a route that either participates in or avoids the PACOTS. Once a flight plan is accepted by ATC, a detailed clearance is issued to the flight. It specifies the names or latitude and longitude of the waypoints defining the route. The clearance will not include the PACOTS designator letter or number even when a PACOTS route is utilized.

Oakland and Tokyo coordinate the development of the tracks, and they are generally given numbers on east to west routes and letters west to east routes. It is important to note that, unlike the NAT tracks, these routes are not reflected in a "track message," but rather as NOTAMS issues by Oakland ARTCC.

Current details of the system including FIRs, city pairs, track designator letters and numbers, separation standards, ATC procedures, and other pertinent information is in the Jeppesen Enroute Section, Continental Airlines International Flight Operations Guide (IFOG), and Jeppesen 1 P (HI) Enroute Chart. Given the frequency of PACOTS changes, it is important to consult the Jeppesen NAVDATA NOTAMS, CHART NOTAMS and Jeppesen 1 P (HI) Enroute Chart to review the status of the routes and procedures.

City pairs and track designators commonly encountered by Continental aircrews are:

North America to Japan	C, D, E, F & G
Japan to North America	1, 2, 3 & 4
Dallas Ft. Worth to Japan	M
Japan to Dallas Ft. Worth	8

The following is an example of a PACOTS NOTAM:

- ① A2689/02 NOTAMN A) KZOA B) 0207010700 C) 0207012300 E)
- ② TDM TRK 8 020701070001
- ③ 0207010700 0207012300
- ④ CALMA 40N160E 42N170E 43N180E 44N170W 45N160W 47N150W 48N140W PRETY
TAMRU SEFIX TOU PDT OGD HBU PNH UKW KDFW
- ⑤ RTS/GUPPY OTR8 KAGIS A590 PABBA OTR5 CALMA
- ⑥ UKW KDFW
- ⑦ RMK/0 01 JUL 07:00 UNTIL 01 JUL 23:00

Explanation:

- ① **A2689/02** NOTAMN A) KZOA B) 0207010700 C) 0207012300 E)

The number / date of the NOTAM, “N” for new NOTAM, issued by Oakland Center (KZOA), effective from 2002 July 01, 0700Z to 2002 July 01, 2300Z.

- ② TDM TRK 8 0207010001

Track Data Message, track 8 on 2002 July 01, 0001z.

- ③ 0207010700 0207012300

Repeat of time / date group for effectiveness.

- ④ CALMA 40N160E 42N170E 43N180E 44N170W 45N160W 47N150W 48N140W PRETY
TAMRU SEFIX TOU PDT OGD HBU PNH UKW KDFW

Fixes of track 8 that begin near Tokyo and end near the arrival fix UKW for KDFW.

- ⑤ RTS/GUPPY OTR8 KAGIS A590 PABBA OTR5 CALMA

Route Track System, is from Guppy via **Oceanic Transition Route 8** to KAGIS, A590 to PABBA, OTR5 to CALMA (and then picking up CLAMA and the routing to KDFW).

- ⑥ UKW KDFW

UKW (Bowie) arrival fix for KDFW.

- ⑦ Remarks and restriction.

ICAO Airport Identifiers

ICAO Airport Identifiers consist of four letters coded to designate general geographic location, the country or state, and the airport ID. The first letter is the general location, the second the country / state, with the third and fourth letters used to identify a specific airport.

The ICAO designation identifiers may be found on the Jeppesen Approach Plate pages. For large or international airports, the identifier is printed at the top of the 10-9 Airport page. The ICAO identifiers for less congested airports may be found at the top of the reverse side of the 11-1 page. For complete worldwide reference to both ICAO and IATA codes, consult the Airport Directory section in the International Jeppesen Manual. Also, refer to the B777 AIRPORT SUMMARY GUIDE for addition information.

Area of Magnetic Unreliability

Flights may be routed through the area of magnetic unreliability (AMU). In the Canadian territories, the line defining the boundaries of the Southern / Northern Control Area also defines the limits of the AMU. In other parts of the world, the limits are not as clearly defined. However, in all cases the appearance of the “T” following the course on an airway (i.e., 342° T) reflects the true course between the defining fixes as opposed to the normal magnetic course (with no alphabetic suffix following the course numbers).

Example:



AMU Operating Policies

- During preflight, check to see if the filed route will penetrate the AMU. These routes include NCA 23, 24, 28, 30 and all DIRECT routes between fixes located within the AMU.
- Cross check the flight plan to ensure correct true and magnetic course are reflected on these legs.

Note: Flight plans include a M/C (magnetic course), M/H (magnetic heading), T/C (true course), and TH (true heading) columns.

- During the preflight verification of the flight plan, it is not necessary or desired to select TRUE on the heading reference switch.
- No changes or additions are required to the Enroute Compass Check.
- The heading reference will *not* automatically change when entering the AMU and the crew should *not* manually select the heading select switch to TRUE. The B777 navigation system is designed to automatically make all necessary corrections and no crew intervention is required. LNAV, heading select, and heading hold all function normally.

Note: The execution of an instrument approach to an airport located within the AMU is not authorized **since these airports have procedures referenced to true north.**

- Continental Airlines does not designate any airport within the AMU as an ETOPS alternate. **These are EMERGENCY USE ONLY airports and should only be considered in extreme emergencies when continued flight is no longer an option.**
- Alternate navigation functions of the FMC do not change and are fully capable of navigation within the AMU, given the system constraints as described in the B777 Flight Manual, Section 6.11.

Note: Do not confuse **FMC Polar Operations** as discussed in Section 6.11 of the B777 Flight Manual (where the heading reference automatically changes to TRUE) with AMU operations.

For additional information refer to ENROUTE ETOPS, Northern Control Area / Polar Region section. Also, refer to the IFOG Manual Section 6, POLAR, RUSSIA & FAR EAST for information on operations in these regions.

Fuel Requirements

ETOPS Fuel Requirements

		120 ETOPS						SC 4	
FLIGHT	DAY	ORG	DEST	ALTN	ACFT TYPE	ENGINES	AC		
28	15	KEWR	EGKK	EGLL	B777-200	GE90-90B	005		
SPEED SCHEDULES		CLIMB	310.M84	CRZ M84	DESCENT M84.310	RT Y			
	FUEL	TIME	OEW	3225	LIMIT	COST INDEX	180		
①	BURN	0880	06.15	PYLD	0800	FUEL COST	0.8302		
②	ALTN EGLL	0043	00.17	ZFW	4025 4300	CRZ ADJUST	3.8		
③	RSV 10PCT	0077	00.37	FOB	1139 3030	AVG W/COMP	P023		
④	RSV 30MIN	0061	00.30						
	CONT	0000	00.00	TOW	5129 6480	AVG OAT	M52		
⑤	ETOPS ADD	0013	00.06	BURN	0880	ADL BO/1000	0140		
	MIN FUEL	1074	07.45	LGW	4249 4600	OUT 23.55Z OFF	00.23Z		
	TAXI	0035	00.28	FUEL OVER DEST	0224			
⑥	EXTRA	0030	00.15	FUEL OVER ALTN	0181	ON 06.36Z IN	06.45Z		
	GATE FUEL	1139	08.28					

Explanation:

BURN

① Fly to and land at the airport to which it is released.

② ALTN EGLL

In addition, to fly to and land at the most distant alternate if one is required.

- If the flight is scheduled for 6 hours or less and the weather forecast indicates an alternate is not required, no alternate fuel is required.
- When the route to be flown does not have an available alternate airport for the destination, total fuel requirements would equal burnoff plus two hours fuel at normal cruising consumption (30,000 lbs for the B777). When using the 2 hour fuel requirement, reserve and contingency fuel are not required.
- When dispatched to a single runway airport without an alternate, there must be enough planned fuel to fly to a suitable contingency airport consuming no more than 50% of the fuel planned to be on board on arrival at the destination. Weather conditions at the contingency airport must meet the same requirements as a destination airport when dispatched without an alternate.

③ RSV 10PCT

After that, to fly for a period of 10% of the total time required to fly from the departure airport and land at the airport to which it was released. On a Redispach Flight Plan, this will be the INITIAL DESTINATION as opposed to the FINAL DESTINATION.

- CAL policy is 10% of the total time using a fuel flow rate equal to that of the final cruise segment.

④ RSV 30MIN

Thereafter, to fly for 30 minutes minimum at holding speed at 1500 feet above the alternate airport or the destination airport if no alternate is specified. This calculation is based on fuel flows at actual landing weights.

⑤ ETOPS ADD

The ETOPS ADD critical fuel requirement is usually covered adequately by the normal flag fuel requirements. However, for a flight with strong tailwinds, it may require more fuel to fly from the last Critical Point into the wind at FL100 to the last ETOPS diversion airport on one engine (with the worst case contingencies applied), than it would to fly as planned at altitude with both engines operating to the final destination airport.

In addition, if the Dispatcher adds contingency fuel, the contingency fuel will be displayed within the ETOPS ADD row on the flight plan. This will be the case until the contingency fuel is greater than the ETOPS ADD, at which point the balance will be displayed in the CONT row. A statement at the end of the flight plan will explain how much contingency fuel has been assigned to ETOPS ADD.

⑥ EXTRA

EXTRA fuel is fuel that has been added by the Captain or Dispatcher that is not required by the FARs. Examples are tanking or fuel added by the Captain. Additional fuel requests must be coordinated by the Captain, Dispatcher, and Load Planning, in sufficient time to avoid payload restrictions, fueling delays, or other operational problems.

ETOPS Critical Fuel Analysis

In addition to Flag Fuel requirements, fuel reserves at the Critical Point must also be provided for “Critical Fuel” contingencies. These contingencies are the loss of pressurization or the loss of pressurization + an engine failure at the Critical Point followed by:

- Immediate descent to FL100 and
- APU is started as a backup electrical source and
- Engine and Wing anti ice penalty is applied and
- A 5% fuel penalty for possible inaccurate winds at FL100 and
- Upon reaching the planned ETOPS enroute alternate at 1500 ft, a hold of 15 minutes and
- Planned approach, missed approach, and a subsequent approach and landing

Note: While the critical fuel requirements are calculated on a descent to FL 100, this altitude may not be immediately attainable due to high terrain, weather, etc.

Note: The B777 has supplemental oxygen of approximately 22 minutes. The crew may elect to temporarily level at FL140 for fuel conservation, terrain or avoid icing condition.

This is a sample of an ETOPS analysis from a Flight Plan with the Enroute Alternates displayed for critical fuel requirements. A detailed explanation follows.

-----ETOPS ANALYSIS-----
 C-EEP N51 44.4 W043 38.5 TIME 02.55 FUEL 0473 FRMG 0631
 C-EXP N52 02.8 W021 14.8 TIME 04.32 FUEL 0692 FRMG 0412
 ETOPS ENTRY AIRPORT CYQX
 ETOPS EXIT AIRPORT EINN
 EARLIEST/LATEST ARRIVAL TIME FOR THE ETOPS ALTERNATE AIRPORTS
 BASED ON ETD
 ① CYQX SUITABLE 0249Z/0621Z
 BIKF SUITABLE 0423Z/0631Z
 EINN SUITABLE 0419Z/0626Z

 SUITABLE ALTERNATES - CYQX / -BIKF
 ② CRITICAL POINT- N52 06.2 W034 15.7
 ③ TIME FROM DEP - 03.36
 ④ FUEL BURN - 0567
 ⑤ F/R OVER ETP - 0537
 ⑥ TIME FROM ETP TO ALTERNATES/ 01.49 BASED ON SINGLE ENG ETOPS DESCENT
 FL 100

	ETP / CYQX	ETP / BIKF
⑦ CRUISE DIST/PLUS 20NM	0818	0823
AVG WIND COMP/FL 100	M15	M11
AVG TEMP/FL 100	P03	M06
WEIGHT AT ETP - 4512		

	⑨	⑩	⑨	⑩
⑧ CRITICAL FUEL CALCULATION	2ENG	1ENG	2ENG	1ENG
⑪ CRUISE / FL100 - 0363 02.24	0372	0360	0367	0363
⑫ HOLDING/1500FT - 0029 00.15	0030	0030	0029	0029
⑬ MISSED APPCH - 0040	0040	0040	0040	0040
⑭ APU BURN - 0006	0000	0006	0000	0006
⑮ A/I ICE DRAG - 0035	0000	0000	0026	0035
⑯ ANTI-ICE - 0000	0021	0021	0000	0000
⑰ ADDL 5 PCT RES - 0020	0020	0019	0019	0020
⑱ TOTAL FUEL REQD - 0493 02.39	0483	0476	0481	0493

SUITABLE ALTERNATES - BIKF / -EINN
 CRITICAL POINT - N52 01.2 W030 28.9
 TIME FROM DEP - 03.53
 FUEL BURN - 0605
 F/R OVER ETP - 0499
 TIME FROM ETP TO ALTERNATES/ 01.43 BASED ON SINGLE ENG ETOPS DESCENT
 FL 100

	ETP / BIKF	ETP / EINN
CRUISE DIST/PLUS 20NM	0781	0811
AVG WIND COMP/FL 100	M08	P06
AVG TEMP/FL 100	M09	M05
WEIGHT AT ETP - 4474		
CRITICAL FUEL CALCULATION	2ENG 1ENG	2ENG 1ENG
CRUISE / FL100 - 0342 02.16	0345 0342	0344 0342
HOLDING/1500FT - 0029 00.15	0029 0029	0029 0029
MISSED APPCH - 0040	0040 0040	0040 0040
APU BURN - 0006	0000 0006	0000 0006
A/I ICE DRAG - 0033	0025 0033	0025 0000
ANTI-ICE - 0000	0000 0000	0000 0020
ADDL 5 PCT RES - 0019	0018 0019	0018 0018
TOTAL FUEL REQD- 0469 02.31	0457 0469	0456 0455

Explanation:

- ① CYQX SUITABLE 0249Z/0621Z
 BIKF SUITABLE 0423Z/0631Z
 EINN SUITABLE 0419Z/0626Z

The times listed are based on the ETD and comply with the Advisory Circular Alternate Airport section which requires weather criteria be considered for the period commencing one hour prior to the established **earliest** time of landing, and ending one hour after the established **latest** time of landing at the ETOPS Enroute Alternate Airport. See the definition of ETOPS Alternate Suitability Time Calculations.

- ② CRITICAL POINT—N52 06.2 W034 15.7

The Critical Point is the point on the intended route where the one engine inoperative diversion time at FL100 from two depicted alternates is equal. It is not necessary for the Critical Point to always fall within the *overlap* of the AOA circles. On an eastbound flight with a strong tailwind, the Critical Point will be further to the west than on a flight with a smaller tailwind.

- ③ TIME FROM DEP - 03.36

The total elapsed time from departure to the Critical point.

- ④ FUEL BURN - 0567

The fuel burn from departure to the Critical point.

- ⑤ F/R OVER ETP - 0537

Fuel remaining at the Critical point. This figure may be compared with the TOTAL FUEL REQUIRED in the CRITICAL FUEL CALCULATION Section.

- ⑥ TIME FROM ETP TO ALTERNATES / 01.49 BASED ON SINGLE ENG ETOPS DESCENT FL 100

Time based on the Single Engine Diversion speed at FL 100.

- ⑦ CRUISE DIST/PLUS 20 NM 0818 1823

The most direct distance from Critical point to ETOPS Enroute Alternates plus 20 miles for ATC and/or unplanned contingencies.

- ⑧ CRITICAL FUEL CALCULATION

The following calculations are based on forecast wind conditions and include both the engine failure scenario and the decompression scenario from the most critical point to the **Suitable** ETOPS Enroute Alternate Airport.

⑨ 2ENG

Fuel required for decompression scenario. Based on immediate descent from cruising altitude to FL 100, and diversion to a **Suitable** airport on two engines.

⑩ 1ENG

Fuel required for a engine shutdown and windmilling at the most critical point, driftdown to FL 100, and diversion to a **Suitable** airport at the approved single engine speed.

The following fuel figures are from the adjacent column representing the most restrictive of the four scenarios considered (i.e., ETP to CYQX with 2 ENG or 1 ENG, and ETP to BIKF with 2 ENG or 1 ENG).

⑪ CRUISE / FL100 - 0363 02.24

The time shown is the most conservative and not governing since it is based on forecast winds, not still air. Descent to 1500 feet is also included in this segment.

⑫ HOLDING/1500FT - 0029 00.15

Holding calculation over the **Suitable** airport at 1500 feet for 15 minutes.

⑬ MISSED APPCH - 0040

Fixed fuel amount for approach, missed approach and subsequent approach and landing.

⑭ APU - 0006

APU fuel calculation based on 425 pounds per hour including cruise, descent and 15 minutes holding over the **Suitable** airport plus approach, missed approach, subsequent approach and landing.

⑮ AI + ICE DRAG - 0035

AI + Ice Drag fuel is an additional fuel requirement that accounts for Engine and Wing Anti-ice plus the accumulation of ice on unheated surfaces. This value is only computed when icing is forecast at FL100. Otherwise, AI +Ice Drag fuel will be given a zero fuel value.

⑯ ANTI-ICE - 0000

The additive fuel value for use of anti-ice systems (engine and wing) is always applied even if there is no icing forecast.

In the case where AI + Ice Drag fuel is zero (no icing forecast), the Anti-Ice fuel penalty will be shown on the Anti-Ice line. If icing is forecast, this penalty will be combined with the ice drag penalty and shown on the AI + Ice Drag line. The Anti-Ice penalty is based on the total time required for cruise, descent and 15 minutes holding plus the approach, missed approach, and subsequent approach and landing.

- ①⑦ ADDL 5 PCT RES - 0020

An additional 5% of cruise fuel is required for wind forecasting errors.

- ①⑧ TOTAL FUEL REQD - 0493 02.39

The sum of the above reflects the most conservative of the various calculations including forecast wind.

Jeppesen Chart / Nav Data NOTAMS and Enroute NOTAMS

Check the NOTAMS, Jeppesen Chart NOTAMS, Jeppesen Nav Data NOTAMS, Jeppesen Enroute Section, and the Jeppesen Air Traffic Control Section, for the Area, Country, Destination, and Alternate. Also, check the airport Jeppesen -7 page.

Chart NOTAMS and other information included under special tabs in the Jeppesen Manual should be reviewed prior to entering foreign airspace. Frequently routes, frequencies, procedures, and restrictions are published in the Chart NOTAMS, Air Traffic Control, and Enroute sections well before such changes are reflected on the Jeppesen Maps, Approach Charts, or Area Charts. It is essential that this information be reviewed prior to operations over these routes.

Weather

Destination Weather

The weather at the destination need not be forecast to have landing minimums at the estimated time of arrival if the destination alternate is forecast to be at or above alternate minimums at the estimated time of arrival at the alternate.

Destination Alternate Requirement

At least one alternate airport must be named for the destination with the following exceptions:

If the flight is scheduled for not more than 6 hours and for at least one hour before and one hour after the estimated time of arrival at the destination airport, the weather reports indicate the following:

- A ceiling of at least 1500 feet above the lowest circling MDA, if a circling approach is required and authorized for that airport, or
- A ceiling of at least 1500 feet above the lowest published instrument approach minimum or 2000 feet above the airport elevation, whichever is greater, and
- The visibility at the destination airport will be at least 3 miles, or 2 miles more than the lowest applicable visibility minimums for the approach to be used, whichever is greater.

When the route does not have an available alternate airport for the destination, the reserve requirement is 2 hours of fuel at normal cruising consumption.

ETOPS Enroute Alternate Weather

The following criteria apply to ETOPS enroute alternate airports for dispatch purposes only.

If there is any condition in the main body of the TAF or conditional phrases (TEMPO, PROB, or BECMG) that contains a forecast that is below ETOPS alternate weather minimums during the suitability time period, then the station does not meet the dispatch requirements as an ETOPS alternate.

Enroute alternates are identified and listed in the Dispatch Release and the ETOPS analysis for all cases where the planned route of flight contains a point more than one hour flying time at the one-engine speed from an Adequate airport. An airport will not be listed as a **Suitable** enroute alternate unless:

The latest available forecast weather conditions for a period commencing one hour before the established earliest time of arrival and ending one hour after the established latest time of arrival at that airport, equals or exceeds the authorized weather minima (REF: Ops Spec C55) indicated as follows:

- A single Precision / Non-Precision equipped runway:

For airports with at least one operational navigational facility providing a straight-in non-precision approach procedure, or a straight-in precision approach procedure, or when applicable, a circling maneuver from an instrument approach procedure; a ceiling derived by adding 400 feet to the authorized Category I HAT or, when applicable, the authorized HAA and a visibility derived by adding 1sm / 1600m to the authorized Category I landing minimum may be calculated.

- Two or More Separate Precision / Non-Precision Equipped Runways:

For airports with at least two operational navigational facilities, each providing a straight-in non-precision approach procedure or a straight-in precision approach procedure to different, suitable runways; a ceiling derived by adding 200 feet to the higher Category I HAT of the two approaches used and a visibility derived by adding 1/2sm. / 800m to the higher authorized Category I landing minimum of the two approaches used may be calculated.

Note: For ETOPS alternates, opposite landing directions on a single runway do not constitute two different runways.

ONE OPERATIONAL NAVIGATION FACILITY					
<div>➤ at least one operational navigation facility (GPS is considered a facility if there is a GPS or RNAV approach) <i>regardless of the number of runways</i> or</div> <div>➤ only one runway (one single runway surface as opposed to 2 separate surfaces) regardless of the number of navigation facilities and</div> <div>➤ a straight in Precision approach (not including PAR) or</div> <div>➤ a straight in Non-Precision approach including ASR or</div> <div>➤ a Circling Approach from an instrument approach (wx at least 1000'/ 3 SM or category D minimums which ever are higher) to</div> <div>➤ at least 2 suitable runways (length, width, wt bearing, markings, lighting, wind components, wx limitations, and contamination/ braking considerations)</div>			<div>ETOPS ALTN CEILING requirements</div> <div>Add 400' to the lower of :</div> <div><div>CAT I ILS DA(H)</div><div>or</div><div>Non Precision MDA(H)</div><div>or</div><div>Circle to Land MDA(H) 1000' / 3SM or Cat D mins</div></div>	<div>ETOPS ALTN VISIBILITY requirements</div> <div>Add 1SM (1600m) to the visibility requirement for the same approach</div>	
			LOWEST MINS AVAILABLE		
			600'	1½ SM 2400m	
			CHARTED MINIMUMS and ETOPS ALTN CEILING / VIS REQUIREMENTS		
CHARTED DA(H) MDA(H) (feet)	ETOPS ALTN CEILING REQ'D (feet)	CHARTED VIS (SM)	ETOPS ALTN VIS REQ'D (SM)	CHARTED VIS (meters)	ETOPS ALTN VIS REQ'D (meters)
000-200	600	1/2	1 1/2	800	2400
201-300	700	3/4	1 3/4	1200	2800
301-400	800	1	2	1600	3200
401-500	900	1 1/4	2 1/4	2000	3600
501-600	1000	1 1/2	2 1/2	2400	4000
601-700	1100	1 3/4	2 3/4	2800	4400
701-800	1200	2	3	3200	4800
801-900	1300	2 1/4	3 1/4	3600	5200
901-1000	1400	2 1/2	3 1/2	4000	5600
1001-1100	1500	2 3/4	3 3/4	4400	6000
1101-1200	1600	3	4	4800	6400

TWO OPERATIONAL NAVIGATION FACILITIES and TWO SEPARATE SUITABLE RUNWAYS

<p>➤ at least two separate operational navigation facilities (GPS is considered a facility if there is a GPS or RNAV approach, but a LOC BC is not a separate facility from the ILS) each providing a usable approach to a separate, suitable runway (2 separate surfaces)</p> <p style="text-align: center;">and</p> <p>➤ a straight in Precision approach (not including PAR)</p> <p style="text-align: center;">or</p> <p>➤ a straight in Non-Precision approach including ASR</p> <p style="text-align: center;">or</p> <p>➤ a Circling Approach from an instrument approach (wx at least 1000'/ 3 SM or category D minimums which ever are higher)</p> <p style="text-align: center;">to</p> <p>➤ at least 2 suitable runways (length, width, wt bearing, markings, lighting, wind components, wx limitations, and contamination/ braking considerations)</p>	<p>ETOPS ALTN CEILING requirements</p> <p>Add 200' to the higher of the two approaches :</p> <div style="border: 1px solid black; padding: 5px; margin: 5px;">CAT I ILS DA(H)</div> <p style="text-align: center;">or</p> <div style="border: 1px solid black; padding: 5px; margin: 5px;">Non Precision MDA(H)</div> <p style="text-align: center;">or</p> <div style="border: 1px solid black; padding: 5px; margin: 5px;">Circle to Land MDA(H) 1000' / 3SM or Cat D mins</div>	<p>ETOPS ALTN VISIBILITY requirements</p> <p>Add ½SM (800m) to the visibility requirement for the higher of the two approaches</p>
LOWEST MINS AVAILABLE		
400'		1SM 1600m

CHARTED MINIMUMS and ETOPS ALTN CEILING / VIS REQUIREMENTS

CHARTED DA(H) MDA(H) (feet)	ETOPS ALTN CEILING REQ'D (feet)	CHARTED VIS (SM)	ETOPS ALTN VIS REQ'D (SM)	CHARTED VIS (meters)	ETOPS ALTN VIS REQ'D (meters)
000-200	400	1/2	1	800	1600
201-300	500	3/4	1 1/4	1200	2000
301-400	600	1	1 1/2	1600	2400
401-500	700	1 1/4	1 3/4	2000	2800
501-600	800	1 1/2	2	2400	3200
601-700	900	1 3/4	2 1/4	2800	3600
701-800	1000	2	2 1/2	3200	4000
801-900	1100	2 1/4	2 3/4	3600	4400
901-1000	1200	2 1/2	3	4000	4800
1001-1100	1300	2 3/4	3 1/4	4400	5200
1101-1200	1400	3	3 1/2	4800	5600

- The landing distances required as specified in the Airplane Flight Manual for the altitude of the airport, for the runway expected to be used, taking into account **wind conditions, runway surface conditions, and aircraft handling characteristics**, permit the aircraft to be stopped within the landing distance available as declared by the airport authorities and computed in accordance with FARs.
- The airport services and facilities are adequate for an approved approach procedure for the runway.
- For the period commencing one hour before the established earliest time of landing, and ending one hour after the established latest time of landing at the enroute alternate, the forecast must meet any Airplane Flight Manual crosswind, headwind, tailwind, runway condition, and braking action limitation relative to the specific runway(s) available at the ETOPS alternate.

Master Flight Plan

One copy of the flight plan will be identified as the master flight plan by inscribing the word **MASTER** in the top margin.

- No other copy of the flight plan will be so identified. The **MASTER** Flight Plan will be used to load the FMC.
- In addition to the **MASTER** Flight Plan, the Captain may order extra copies of the flight plan if required by a Line Check Airman or other jump seat occupant(s).
- In the event a new flight plan is generated, a new **MASTER** flight plan must be designated and checked. The old “**MASTER**” flight plan should be destroyed to prevent possible confusion.

The Captain, First Officer, and IRO (s), will confirm the following on the Master Flight Plan:

- Master copy labeled.
- Route in the body of the flight plan matches the NAT message, ICAO strip, North American Routes (NAR) common and non-common, domestic routing, etc.

Plotting Chart

Course and waypoint plotting are required on all LRN segments when the crew is unable to accurately fix the position of the aircraft using ground based navigational aids each hour.

The First Officer or IRO should prepare the plotting chart in the weather room and verify the route is within the designated ETOPS AOA diversion distances. The data listed below will be transcribed from the Master Flight Plan.

The plotting chart will include, as a minimum:

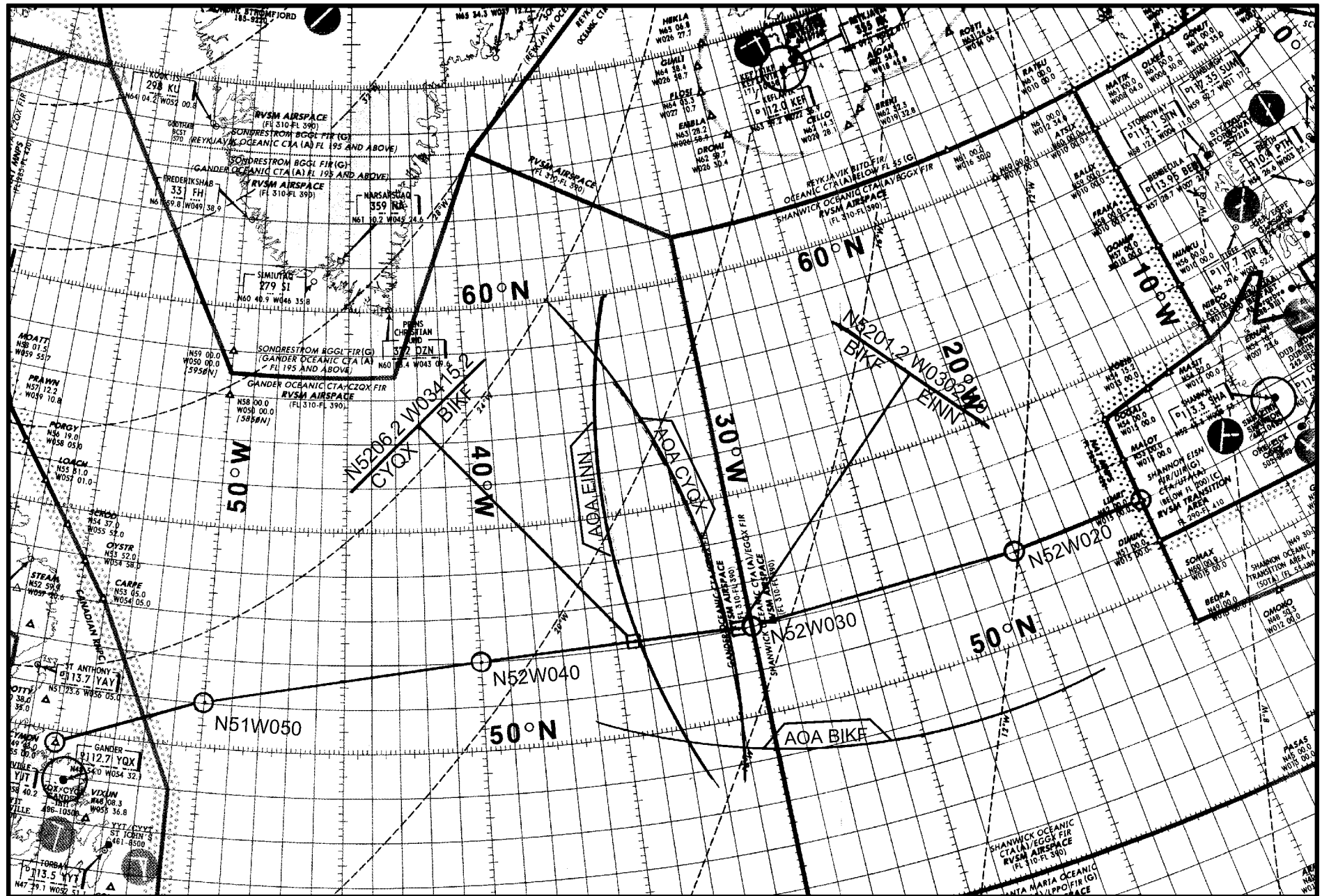
- Waypoints, course lines, and waypoint labeling.
- AOA circles with identifying **Suitable** alternate labels.
- Critical point position with coordinates and **Suitable** alternate labels.

For ETOPS operations identify the assigned **Suitable** alternates and scribe the 75, 90, 120, 138, 180 or 207-minute arcs, as appropriate, for the flight. Use the Jeppesen plotter or a compass for scribing the AOA. Additional arcs may have to be added enroute if changes are made to the route of flight or ETOPS enroute **Suitable** alternates are revised. The planned route must lie within the AOAs. If it does not, a new flight plan must be obtained. If a subsequent route change occurs, the defined arcs will help to determine if the new route is acceptable or if different enroute **Suitable** alternates should be selected.

The waypoints should be plotted and labeled identically to the Master Flight Plan. Course lines are then drawn between the waypoints. If the route or waypoints are preprinted on the Plotting Chart, check their accuracy with current Jeppesen navigation charts.

The following example illustrates how the mandatory items appear on the plotting chart prior to leaving the weather room.

INTENTIONALLY LEFT BLANK



INTENTIONALLY LEFT BLANK

AIRCRAFT PROCEDURES

FLIGHT DECK PREPARATION

Preflight - Aircraft

Check the maintenance logbook to verify ETOPS pre-departure check is complete and that any MEL items are compatible with the flight release and designated AOA, recalling that certain MEL items can restrict the AOA time/distance. It is also prudent to check the amount of engine oil added on the previous flight.

ETOPS Pre-Departure Check

An ETOPS pre-departure check has been developed to confirm the status of the aircraft and that certain critical items are acceptable. This check is accomplished and signed off by an ETOPS qualified maintenance person within three hours of *scheduled* departure time. Continental maintenance is responsible for verifying the 3 hour time frame. There is no mechanism for the flight crew to verify the signoff time other than confirming with maintenance via radio.

Any **air return**, regardless of the reason, requires another ETOPS pre-departure check. Any **ground return** or **ground interruption** that occurs for mechanical reasons requires another ETOPS pre-departure check. A ground or gate return for other than mechanical reasons does not require a new pre-departure check.

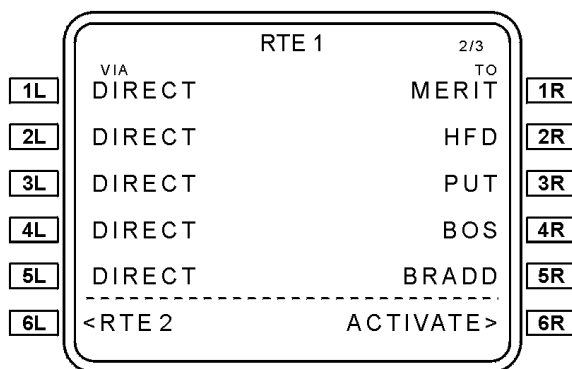
Navigation Kit

Ensure that the navigation kit is on board the aircraft. The contents should be inventoried to verify the appropriate charts are on board. If any charts are missing, they may be obtained from Dispatch via fax. If any charts are missing, a logbook entry should be accomplished upon arrival in KEWR or KIAH.

Loading the Route

The First Officer will uplink or manually program the FMC, and independently verify the CDU ROUTE and **all waypoints** on CDU LEGS pages match with the Master Flight Plan (airways, waypoints).

WARNING: Waypoint loading will be done independently. Do not load the flight plan by reading coordinates to each other. It is imperative that only one pilot load the flight plan into the CDU.



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Note: During the verification procedure it is recommended that the ND be placed in the **PLAN** mode. The crew will receive a visual representation of the route loaded in the CDU.

Latitude / Longitude Waypoints

There are several different ways to load Oceanic or NAT Track Waypoints. The easiest and safest way to load them is to see how they are displayed in the body of the flight plan. It should be possible to load the waypoints in the FMC exactly as they are displayed in the flight plan. The following represent some of the different waypoint entry techniques.

Latitude / Longitude (Lat/Lon) Waypoints are pilot-entered or FMC-created waypoints defined by a specific geographic (latitude / longitude) location. Lat/Lon waypoint entries are of the form "axxbxxx" or "axxxx.xbxxxxx.x," where "a" is the "N" or "S" latitude designator, "b" is "E" or "W" longitude designator, and "xx..." is the degrees or degrees / minutes (with tenths). The degrees portion must be a two or three-digit value for the latitude and longitude, respectively. If minutes are entered, they must also contain tenths of minutes. For example, a waypoint at N52°10.8' latitude and E001°05.1' longitude would be entered as "N5210.8E00105.1," but a position at N49°00.0' and W050°00.0', could be entered as "N49W050."

Lat/Lon waypoints are displayed as "axxbxxx" where "a" is "N" or "S" designator, "b" is "E" or "W" designator, and xx or xxx is the whole degree portion of the waypoint (truncated). This could possibly result in different waypoints with the same identifier, but the FMC recognizes the Lat/Lon waypoints by exact position. Scratchpad selected Lat/Lon waypoints are displayed in expanded form (degrees / minutes / tenths of minutes).

It may be necessary to load a coded waypoint to facilitate using a "UN" route to the initial coast out fix of Europe or Ireland. To codify whole degree waypoints using the five character designator stored in the FMC database use "N" for North Latitude / West Longitude, "E" for North Latitude / East Longitude, "S" for South Latitude / East Longitude, and "W" for South Latitude / West Longitude. Construct the identifier using two digits each for the degrees of latitude and longitude respectively. Always specify the latitude digits first. If the longitude value contains three digits (i.e., 120), use only the last two digits (i.e., 20).

Place the letter designator in the identifier as the fifth character if the longitude value is less than 100 degrees, or place the letter as the third character if the longitude value is 100 degrees or more. This, in effect, has the letter replacing the first "1" in the longitude value. The following examples illustrate the coding procedures just described:

North Lat / West Long

N52W015 = 5215N

N07W008 = 0708N

N75W170 = 75N70

N08W130 = 08N30

North Lat / East Long

N50E020 = 5020E

N08E008 = 0808E

N75E150 = 75E50

N06E110 = 06E10

South Lat / West Long

S52W075 = 5275W

S07W008 = 0708W

S76W160 = 76W60

S07W120 = 07W20

South Lat / East Long

S50E020 = 5020S

S06E008 = 0608S

S76E160 = 76S60

S06E110 = 06S10

Coded waypoints can be used in the FIX page.

For the fixed routes in the Pacific, each waypoint has a five-letter identifier. Although the waypoint could be placed in the FMC by entering its complete latitude and longitude, the most efficient method would be to enter the five-letter identifier that matches the flight plan. This will also provide a ready reference to the identity of the waypoint rather than WPXX if the Lat/Lon were used.

The actual position of the waypoint can always be verified by entering the identifier on the REF NAV DATA page of the FMS.

For all random routes, as well as the variable track system in the Atlantic, a similar system of five character identifiers is available even though they are not illustrated on the orientation chart.

Note: **Do not load C-EEP, Critical Point, or C-EXP coordinates as waypoints on the ACT RTE 1 LEGs pages.** This will only add confusing information to the POSITION REPORT page and create erroneous ADS reports.

C-EEP/C-EXP should be displayed by placing the appropriate ETOPS enroute alternate airport (as identified on the flight plan) 4 letter ICAO identifiers on FIX page 1 and 2, with a "/453" to graphically display their relationship with the active route.

Late Route Change

If last minute route changes occur, it is more important to load and properly verify the first few waypoints than to rush through the entire loading procedure. Rushing would jeopardize the accuracy of the verification procedure.

Additional waypoints can be loaded and properly confirmed when time permits.

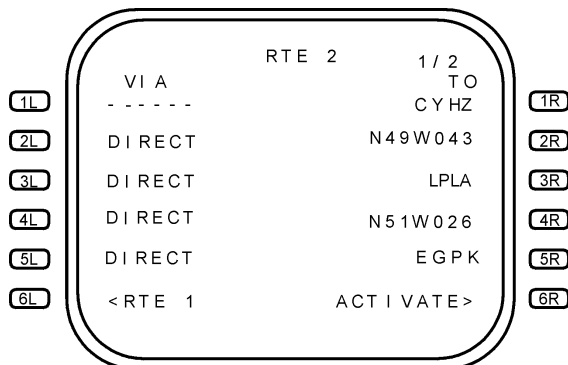
For example, a flight originating in London Gatwick for Houston via 55N/10W, etc., is rerouted via 56N/10W, etc. In this case, it would only be necessary to load and verify "N56W010" prior to departure. Load and verify the remainder of the new clearance when the workload permits.

Loading Route 2

Although there are a number of ways to load RTE 2 (RTE COPY, etc.), it must include the following as a minimum:

- 1st ETOPS Enroute Alternate Airport
- Critical Point between 1st and 2nd ETOPS Alternate Airports
- 2nd ETOPS Enroute Alternate Airport
- Critical Point Between 2nd and 3rd ETOPS Alternate Airports
- 3rd ETOPS Enroute Alternate (and same format if more than 3)
- Discontinuity
- Escape route (if required)
- Destination Airport (Optional)
- Destination Alternate Airport with anticipated routing from destination (Optional).

A typical example might look like this:



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Escape Routes

If the flight is over or near **high terrain**, then the appropriate depressurization escape routes should be loaded into RTE 2. These escape routes are used for diversion airports associated with mountainous terrain that would not normally permit descent to 10,000 MSL. These routes are found in the Jeppesen -7 pages and can be programmed in RTE 2 using the appropriate waypoints and airways. In addition, by creating a discontinuity between each of the decision points, aircraft present position and relationship of the escape route can be graphically shown on the EFIS map. Suggested loading is as follows:

- Waypoint defining one end of the FIRST escape route / airway
- Specific airway / route in the VIA column
- Waypoint defining the other end of the FIRST escape route / airway
- Discontinuity
- Waypoint defining one end of the SECOND escape route / airway
- Specific airway / route in the VIA column
- Waypoint defining the other end of the SECOND escape route / airway
- Discontinuity
- Additional escape routes in the same format
- Discontinuity
- Destination (Optional)
- Alternate Airport with anticipated routing from destination (Optional).

A typical example (Rio Negro, Taboga Island, NENER, and Cali) might look like this:

	RTE 2		1 / 2	
1L	V I A		T O	1R
	- - - - -		R N G	
2L	A 3 2 3		T B G	2R
3L	- - - - -		□ □ □ □	3R
4L	D I R E C T		N E N E R	4R
5L	W 3		C L O	5R
6L	< R T E 1		A C T I V A T E >	6R

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Additionally, there may be particular airports where the engine-out departure or missed approach procedure would dictate the loading of a special escape route or alternate route.

To view Route 2 simply select the RTE 2 prompt (6L) on the ACT RTE 1 page. A blue dashed line and additional white waypoints appears on the respective ND. This allows viewing of critical points, the alternate airports, or the depressurization escape routes overlaying the ACT RTE 1 segment of the flight plan.

Caution: Do not activate or execute RTE 2 unless you intend to actually fly Route 2.

Waypoint Loading Verification

The following procedures are comprehensive. The objective is to identify and eliminate errors. It is imperative to use all available resources to confirm the following agree.

- Continental Flight Plan
- ICAO Flight Plan (strip)
- NAT Track Message
- Airway NOTAMS
- FMC/NAV Data
- PDC/Clearance

Prior to coordinating with the First Officer, the Captain will also verify the CDU ROUTE and all waypoints on CDU LEGS pages match with the Master Flight Plan (airways, waypoints). This is intended as an **independent verification**.

Caution: It is important to check that all FMC waypoints agree with the MFP. Uplinks are received as a route with airway designators (such as LIT J180 DAS). The FMC searches its airway database and fills in the individual waypoints along the uplinked route. Airways are routinely modified / changed by NOTAM. Once dispatch receives a change, the flight planning computer is updated to reflect the current NOTAMS. To the contrary, the FMC database is only updated every 28 days. If discrepancies are found, check with Dispatch or ATC for the proper routing.

Once the **independent verification** described above is complete, the First Officer, working in coordination with the Captain, will use the **PLAN/STEP** mode and FMC LEGS PAGES, and read aloud only the necessary waypoints (see below) to the Captain.

The Captain, using the Master Flight Plan, will:

- Circle the waypoint (as required) and respond, "CHECKED."
 - It is only necessary to circle the waypoints for the portion of the flight that is:
 - Not in radar contact and not receiving continuous FMC radio updating using ground based navigation aids at least once each hour, or
 - Anytime in Russian airspace (even with radar coverage) without continuous FMC radio updating.

Once the PDC/ATC clearance is received, the Captain and the First Officer will verify that the FMC route agrees with the PDC/ATC clearance.

Note: If the PDC/ATC Clearance involves rerouting, the verification procedure described above must be re-accomplished.

The FMS **total enroute distance** will be checked on the PROGRESS page for agreement with the flight plan (typically within a few miles depending upon the particular departure and arrival programmed).

CYMON	N49 43.0 W055 00.0	44	52	00	617 02.02 1.14	0175
	37 074 073 053 052 26016	P014	486	500	2102 04.13	0752
RMNG WGT-	4727 ISA- P04 KIAS-	274	MACH-	.839		

N51W050	N51 00.0 W050 00.0	44	52	00	207 02.26 0.24	0056
	37 091 090 068 066 27034	P030	486	516	1895 03.49	0696
RMNG WGT-	4671 ISA- P04 KIAS-	274	MACH-	.840		

N52W040	N52 00.0 W040 00.0	43	53	01	379 03.11 0.45	0101
	37 102 097 081 075 32056	P023	486	509	1516 03.04	0595
RMNG WGT-	4570 ISA- P04 KIAS-	274	MACH-	.840		

N52W030	N52 00.0 W030 00.0	37	50	04	371 03.55 0.44	0101
	37 108 100 090 081 35081	P014	488	502	1145 02.20	0494
RMNG WGT-	4469 ISA- P06 KIAS-	274	MACH-	.840		

N52W020	N52 00.0 W020 00.0	32	47	04	370 04.37 0.42	0094
	37 104 105 090 091 26039	P039	492	531	0775 01.38	0400
RMNG WGT-	4375 ISA- P09 KIAS-	274	MACH-	.840		

LIMRI	N52 00.0 W015 00.0	35	54	03	186 04.58 0.21	0045
	37 100 103 090 093 25055	P050	484	534	0589 01.17	0355
RMNG WGT-	4330 ISA- P02 KIAS-	274	MACH-	.840		

DOLIP	N52 00.0 W012 00.0	36	56	01	111 05.11 0.13	0028
	37 098 101 090 092 24045	P040	483	523	0478 01.04	0327
RMNG WGT-	4302 ISA- P01 KIAS-	274	MACH-	.840		

ALTITUDE CHANGE TO FL 390 - 0000 MILES / 00.00 MINUTES AFTER - DOLIP						

Predeparture Accuracy Check

This check is accomplished on the ground to confirm that the ADIRU/FMC/CDU units are loaded and operating properly. In order to check the accuracy of the position, compare your known present position (gate or ramp position) to the FMC (GPS) position by performing the Pre-Departure Accuracy Check.

Note: The example portrays a KEWR Gate 106 departure.

- Record the departure gate number and (Jeppesen) charted gate / ramp coordinates in the PREDEPARTURE ACCURACY CHECK box on the plotting chart.
- After ADIRU alignment, record the FMC position (from POS REF 2/3) on the plotting chart.
- Select the (6R) BRG/DIST key and record the Δ distance between the FMC position and the INERTIAL position on the plotting chart. If this distance is greater than .3NM further investigation is required to resolve the position discrepancy.

POS REF		2/3
1L	FMC (GPS) N40°41.8 W074°10.6	UPDATE ARMED
2L	INERTIAL N40°41.8 W074°10.6	INERTIAL NOW>
3L	GPS N40°41.8 W074°10.6	GPS NOW>
4L	RADIO N40°41.8 W074°10.6	RADIO NOW>
5L	RNP/ACTUAL 1.00 / 0.10	DME DME
6L	<INDEX	BRG / DIST>

HF Preflight Check

A reception-only check of the HF radios should be accomplished prior to departure. This is most easily accomplished by selecting and listening to WWV for a GMT transmission signal on frequencies of 5000, 10000, 15000, or BBC Europe 12095 Hz.

Note: If the tuning tone plus HF receptions from other aircraft or WWV broadcasts are audible, the flight may proceed provided enroute HF radio and SELCAL checks are successful prior to transoceanic entry.

WARNING: Do not perform a HF transmissions check if refueling is in progress or any other aircraft in close proximity.

Documents Check

Prior to pushback, the Captain will ensure that the following additional documents are on board:

- Fuel Slip
- Armed Passenger Form (if required)
- Live Animal Form (if required)
- Hazardous Material Form (if required)
- Pre-departure Clearance (PDC) (if available)
- Accuload or Pilot Weight Manifest
- General Declaration (CAL Form FS 561 as required).
- Customs documentation as required.

FMC RESERVE Fuel and Wind Entries

For all flights, both international and domestic, the RESERVES (4L) fuel entry on the PERF INIT page should include the alternate fuel from the flight plan (ALTN), plus 10,000 lbs. International reserve, CONT- Contingency, ETOPS Add, and Extra Fuel are not included to avoid an erroneous **INSUFFICIENT FUEL** message while loading of the FMC.

Note: The FMC RESERVE fuel entry (4L) should normally reflect fuel burn to the alternate (ALTN) plus 10,000 pounds. However, the crew may elect to modify the 10,000 pounds value as required.

FMC fuel predictions, which include fuel over destination on the Progress Page, hold fuel remaining, and the FMC message **INSUFFICIENT FUEL** are reliable only if:

- Forecast winds have been uplinked or manually loaded for the entire route on the ACT WIND pages
- Forecast winds have been loaded for the descent on the DESCENT FORECAST page. These winds are not normally uplinked until 30 minutes after departure and only have a small effect if they are not loaded.
- The flight plan speed / mach number has been selected on the CRZ page.

Note: Continental flight plans are specifically tailored to the assigned ship number and include a “CRZ ADJUST” factor for the individual aircraft that accounts for DRAG / FF differences. It is important to cross check the FMC combined DRAG/FF values to ensure their sum is within 0.3 of the flight plan value.

BEFORE TAKEOFF

Check Proper Runway

The FMC will allow entry of RWY/POS (4L) on the TAKEOFF REF page. Any runway existing at the active origin airport may be entered followed by a slash and a position shift (the distance in feet indicated by FT) that the aircraft is past the runway threshold or a runway intersection for a position update at takeoff.

Caution: The proper runway and position on the runway **must** be verified with the Accuload prior to takeoff. On the ground, the FMC calculates present position based on ADIRU and/or the GPS data.

If GPS NAV is ON, the TO/GA update is inhibited. GPS NAV ON/OFF selection is on POS REF page 3/3. Not only will the programmed runway be displayed; the SID (if chosen) associated with that runway will also be activated.

If GPS NAV is OFF, the FMC updates position to the takeoff runway threshold when a TO/GA switch is pushed. The runway data is on the TAKEOFF REF page. When an intersection takeoff is made, the intersection displacement distance from the runway threshold must be entered on the TAKEOFF REF page.

ICAO Noise Abatement Climb

Many airports in foreign countries specify the use of ICAO noise abatement takeoff profiles, which are detailed in the Normal Procedures section of the Flight Manual. The required profile may be listed on an Airport Noise Abatement Procedure Page, (Continental 10-4 or 10-7). If the country designates no specific procedure, use the FMC default values displayed on TAKEOFF REF 2/2 or the crew should select a climb profile determined to be operationally efficient.

Note: FMC TAKEOFF REF page 2/2 displays supplementary takeoff data. Adjustments to the default values (if required) should be made.

Altimeter Setting Terminology

- QNH** The normal setting as used in the U.S. When set to QNH, the altimeter will read field elevation above MSL with the aircraft on the ground. The term also refers to “altitude” rather than “flight level.”
- QNE** Term refers to the “flight level” standard setting of 29.92” HG (1013 hPa), used primarily for high altitude vertical separation.
- QFE** Term is used to represent the actual atmospheric pressure at the level of the aerodrome or runway threshold. In-flight, when set to a QFE value, the altimeter will indicate height above the aerodrome level or runway threshold level. A QFE setting is sometimes used during the approach and landing at an aerodrome. Altimeter settings within the airspace of Russia are referenced to QFE.

Caution: A QFE altitude reference for the primary flight displays must be selected in the FMC system whenever QFE is used, instead of QNH (on the APPROACH REF page).

Caution: The use of LNAV with QFE active is prohibited with any altitude constrained conditional waypoint.

Caution: The use of VNAV with QFE active below the Transition Level is prohibited.

Transition Altitude or Level

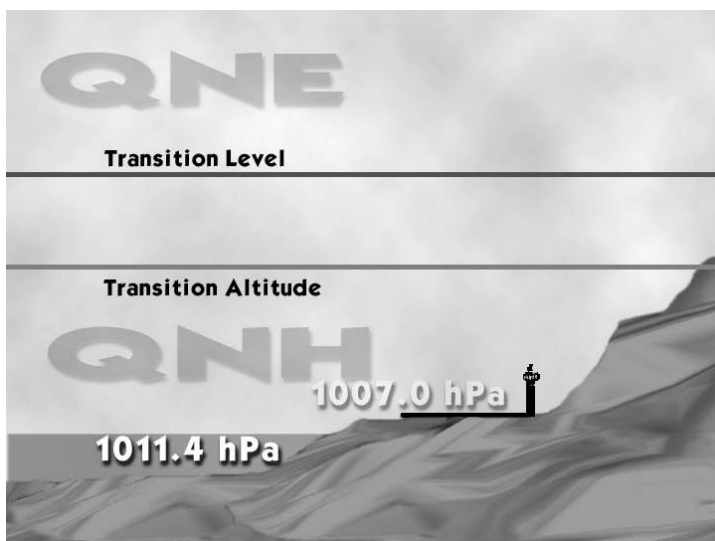
Approach and departure procedures at many airports outside of the U.S. will specify a “Transition Altitude” and/or a “Transition Level.” These terms refer to altitudes where the altimeter will be referenced to local barometric pressure or to 29.92” hg (1013 hPa/millibars).

A Transition Altitude is the altitude at or below which the vertical position of an aircraft is controlled by reference to altitudes or feet above Mean Sea Level (QNH). Clearance to maintain an altitude at or below the Transition Altitude can be confirmed by listening for clearance terminology that refers to an altitude thousands of feet, i.e., “Cleared to maintain nine thousand feet.”

A Transition Level is the lowest flight level available for use above Transition Altitude, where the vertical position of an aircraft is controlled by reference to standard 29.92” hg (QNE). Clearance to maintain a QNE standard altitude above the Transition Altitude can be confirmed by listening for clearance terminology that refers to “Flight Level Niner Zero”, which is 9000 feet indicated with the altimeter reset to standard setting.

Transition Layer

The Transition Layer is the airspace between the Transition Altitude and the Transition Level. Aircraft descending through the transition layer will use altimeters set to local station pressure, while aircraft climbing through the layer will be using a standard QNE setting (29.92" hg).



ENROUTE PRIOR TO COASTOUT

Although the terms COAST OUT and COAST IN are used to denote typical oceanic ETOPS operations, there are times when entry into ETOPS operations is not associated with a water coast line, such as NCA routes from KEWR to RJAA, which have an ETOPS entry point in northern Canada. Remember, ETOPS entry is defined by the Advisory Circular 120-42A as one hour from an Adequate airport. Thus, the checks and procedures associated with COAST OUT and COAST IN should be accomplished at appropriate times depending upon the specific route, the time and location of ETOPS entry, loss of ground base nav aids, loss of VHF communication, necessity for procuring the oceanic clearance, time to accomplish the arrival procedures, etc. Attention to detail and good judgement govern the exact time and place to accomplish many of these procedures.

Radio Communications

At the Captain's discretion, the IRO may be asked to assist with some of the radio communications to help relieve the PM during times of increased communication traffic. Due to the type and extent of overwater radio communications, the tendency for both pilots to get involved in two-way radio communications should be resisted. The PF, however, should monitor all radio communications.

The Captain and one other crewmember must monitor all oceanic clearances. The clearances should be copied on the Master Flight Plan or a copy of the data uplink should be retained.

ADS Log On

Accomplish an ADS LOGON, if required, using the ATC LOGON/STATUS page. This should be accomplished 15 - 45 minutes prior to entry into ADS airspace. ADS airspace is defined as the Oceanic FIR boundary. The 4 letter FIR boundary identifier that is entered on the ATC LOGON/STATUS page can be found on the appropriate orientation chart or plotting chart. Verify ADS connection has been established by reference to the ADS page under the MANAGER menu.

For a detailed description of ADS procedures see Datalink Communications in this section.

Oceanic Clearance

The crew may obtain the oceanic clearance by voice communications or data link depending upon the particular route being flown. Frequencies and procedures for oceanic clearances are presented on the appropriate Atlantic / Pacific Orientation charts (H/L) 1& 2, as well as Jeppesen Enroute pages. Often the Jeppesen -7 pages for the departure airport contain oceanic information.

For a detailed description of Gander and Shanwick Oceanic clearance procedures, see Datalink Communications in this section.

Note: It is the crew's responsibility to obtain the oceanic clearance. The Captain should plan to be on the flight deck to monitor receipt of the oceanic clearance and confirm the FMC is properly programmed.

North Atlantic Track Changes

Should the crew receive a reroute other than that originally flight planned, special caution should be exercised to ensure that the assigned track and the associated landfall and domestic standard routings are fully understood and correctly programmed into the FMC using the waypoint verification procedures described earlier. Normally in the North Atlantic Track system, ATC will make every effort to assign the requested track. Occasionally the number of aircraft planned through a particular track will exceed the capacity of the associated route and it will be necessary for ATC to reroute some aircraft via alternate routes. If the flight is rerouted via an OCA exit point different to that filed in the flight plan, then the flight must follow the standard route associated with its new OCA exit point. When this occurs ATC will normally assign the optional route filed in the ICAO flight plan. The optional track information is located immediately below the main body of the flight plan in the section titled "OPTIONAL ALTITUDE/TRACK" If the oceanic clearance received is for the optional track filed in the ICAO strip the crew should refer to and use the "OPTIONAL ALTITUDE/TRACK" section to ensure the FMC is properly programmed with the correct oceanic and domestic standard routing. In addition, the "OPTIONAL ALTITUDE/TRACK" contains the CRITICAL POINT(s) information necessary for that route.

As always any questions concerning the clearance or standard routing should be resolved with ATC.

The “OPTIONAL ALTITUDE/TRACK” section is included in the body of the flight plan only when flying the North Atlantic Track System (NATS).

The following is an example flight plan containing the “OPTIONAL ALTITUDE/TRACK” information:

```

- - - - - - - - - - OPTIONAL ALTITUDE/TRACK - - - - -
①  OPTIONAL ALTITUDE - NAT Y   FL 360                      RC 9751  PLAN 0102
②  TIME 06.13  BO  0884  DIST 3084  CRZ M84   PYLD 0750      SC 4
    KEWR...MERIT...HFD...PUT...BOS...TUSKY.N91B.CYMON.NATY.DOLIP.UN523.CRK.
    UR37.EXMOR.UR14.GIBSO.WILL1D.EGKK
③  OPTIONAL TRACK - NAT X   FL 370                      RC 9751  PLAN 0103
    TIME 06.16  B/O 0877  DIST 3089  CRZ M84   PYLD 0750      SC 4
    KEWR...MERIT...HFD...PUT...WITCH...ALLEX.N107B.DOTTY.NATX.BURAK.UN533.CRK.
    UR37.EXMOR.UR14.GIBSO.WILL1D.EGKK

TO      LAT. . . LONG. . .      TRP  OA  S  DIST ACTM  TM RETA  FUEL
④  -----
    FREQ  FL M/C M/H T/C T/H  WIND  COMP  TAS  G/S  DRMG  TRMG  ETA  ATA  FRMG
    DOTTY  N50 38.0 W055 35.0      45  52  00  595 02.02 1.11  0168
          37 072 071 051 050 27019 P016 486 502 2105 04.14  0736
    N52W050 N52 00.0 W050 00.0      44  52  00  226 02.28 0.26  0060
          37 092 090 069 067 27039 P035 486 521 1879 03.48  0676
    N53W040 N53 00.0 W040 00.0      43  53  01  371 03.12 0.44  0098
          37 103 097 081 075 32058 P027 486 513 1508 03.04  0578
    N53W030 N53 00.0 W030 00.0      37  50  04  362 03.55 0.43  0100
          37 109 100 090 081 34084 P015 488 503 1146 02.21  0478
    N53W020 N53 00.0 W020 00.0      32  45  03  362 04.36 0.41  0092
          39 104 104 090 090 28028 P028 494 522 0784 01.40  0386
    MALOT  N53 00.0 W015 00.0      34  52  03  182 04.57 0.21  0045
          39 101 104 090 093 24048 P040 487 527 0602 01.19  0341
    BURAK  N53 00.0 W012 00.0      36  55  01  108 05.10 0.13  0026
          39 099 102 090 093 24046 P039 483 522 0494 01.06  0315
    NAT X
    CRITICAL POINT- N53 06.2 W035 30.9
    CRITICAL POINT- N53 03.2 W028 31.6
- - - - -

```

Explanation:

- ① OPTIONAL ALTITUDE - NAT Y FL 360 RC 9751 PLAN 0102
Optional altitude FL 360, for current track NAT Y. Normally 1000 ft below filed track altitude. Also found in remarks of the ICAO strip:
DAT/VS COM/TCAS RMK/ADS AGCS **02.X360** 03.X370)
- ② TIME 06.13 BO 0884 DIST 3084 CRZ M84 PYLD 0750 SC 4
Flight time 06.13, fuel burnoff 0884, and distance 3084, at the optional altitude.

- ③ OPTIONAL TRACK - NAT X FL 370 RC 9751 PLAN 0103
 TIME 06.16 B/O 0877 DIST 3089 CRZ M84 PYLD 0750 SC 4
 KEWR..MERIT..HFD..PUT..WITCH..ALLEX.N107B.DOTTY.NATX.BURAK.UN533.CRK.
 UR37.EXMOR.UR14.GIBSO.WILL1D.EGKK

Altitude FL 370, flight time 06.16, fuel burn off 0877, and distance 30789 for new track. The optional track is normally a track adjacent to the original track. The route description is from departure to destination (including the "Preferred Route" from the new NAT track to destination). Also found in remarks of the ICAO strip:

DAT/VS COM/TCAS RMK/ADS AGCS 02.Y360 **03.X370**)

- ④
- | FREQ | FL | M/C | M/H | T/C | T/H | WIND | COMP | TAS | G/S | DRMG | TRMG | ETA | ATA | FRMG |
|---------|-----|------|------|------|-----|-------|------|-----|-----|------|-------|------|-----|------|
| DOTTY | N50 | 38.0 | W055 | 35.0 | | | 45 | 52 | 00 | 595 | 02.02 | 1.11 | | 0168 |
| | 37 | 072 | 071 | 051 | 050 | 27019 | P016 | 486 | 502 | 2105 | 04.14 | | | 0736 |
| N52W050 | N52 | 00.0 | W050 | 00.0 | | | 44 | 52 | 00 | 226 | 02.28 | 0.26 | | 0060 |
| | 37 | 092 | 090 | 069 | 067 | 27039 | P035 | 486 | 521 | 1879 | 03.48 | | | 0676 |
| N53W040 | N53 | 00.0 | W040 | 00.0 | | | 43 | 53 | 01 | 371 | 03.12 | 0.44 | | 0098 |
| | 37 | 103 | 097 | 081 | 075 | 32058 | P027 | 486 | 513 | 1508 | 03.04 | | | 0578 |
| N53W030 | N53 | 00.0 | W030 | 00.0 | | | 37 | 50 | 04 | 362 | 03.55 | 0.43 | | 0100 |
| | 37 | 109 | 100 | 090 | 081 | 34084 | P015 | 488 | 503 | 1146 | 02.21 | | | 0478 |
| N53W020 | N53 | 00.0 | W020 | 00.0 | | | 32 | 45 | 03 | 362 | 04.36 | 0.41 | | 0092 |
| | 39 | 104 | 104 | 090 | 090 | 28028 | P028 | 494 | 522 | 0784 | 01.40 | | | 0386 |
| MALOT | N53 | 00.0 | W015 | 00.0 | | | 34 | 52 | 03 | 182 | 04.57 | 0.21 | | 0045 |
| | 39 | 101 | 104 | 090 | 093 | 24048 | P040 | 487 | 527 | 0602 | 01.19 | | | 0341 |
| BURAK | N53 | 00.0 | W012 | 00.0 | | | 36 | 55 | 01 | 108 | 05.10 | 0.13 | | 0026 |
| | 39 | 099 | 102 | 090 | 093 | 24046 | P039 | 483 | 522 | 0494 | 01.06 | | | 0315 |
- NAT X
 CRITICAL POINT- N53 06.2 W035 30.9
 CRITICAL POINT- N53 03.2 W028 31.6

The NAT track portion of the flight plan is included. This provides the crew with the necessary information to load and verify the FMC and accomplish waypoint passage procedures. Note that the CRITICAL POINT information is also included for loading route 2.

Once the Captain and First Officer have copied / received the new clearance, it should be cross-referenced with the track message.

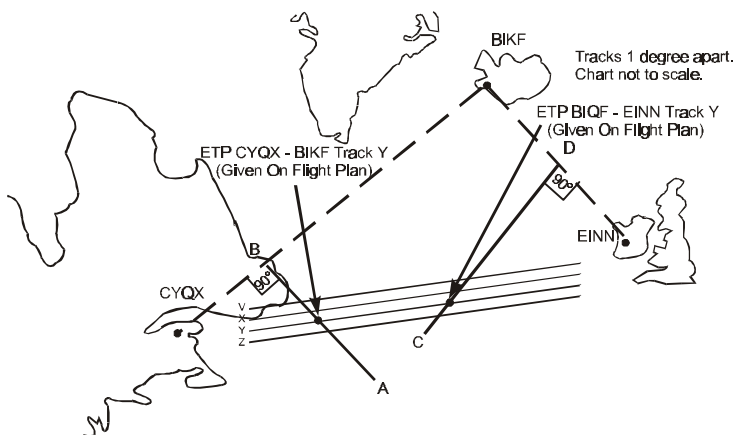
Once the crew agrees on the clearance content, the waypoint information is manually inserted into the FMC using the waypoint loading and verification procedures described in this section. If the track assigned by ATC, is the Optional Track filed in the ICAO flight plan, then the crew, using the OPTIONAL ALTITUDE/TRACK section of the flight plan, has all the necessary information to accomplish the waypoint loading and waypoint verification procedures and Enroute ETOPS procedures.

Ensure the new track is plotted on the plotting chart and cross-referenced with the FMC, NAT track message, and clearance for agreement.

When a reroute is received, use all available means to contact and inform the Dispatcher of the new route flown. The OPTIONAL ALTITUDE/TRACK section of the North Atlantic flight plan contains the necessary CRITICAL POINT information for the optional track should it be assigned. However, if the track assigned is different than that provided in the OPTIONAL ALTITUDE/TRACK section of the flight plan then, it will be necessary to obtain the necessary flight plan information from the Dispatcher.

Another alternative for calculating the new CRITICAL POINT on the plotting chart as follows:

1. Draw a line between the two enroute ETOPS alternate airports from which the CRITICAL POINT is calculated. In the example that follows, this will be done twice, once between CYQX to BIKF and again between BIKF to EINN.
2. From that line draw a perpendicular line that passes through the appropriate CRITICAL POINT. In this example, line A-B for CYQX to BIKF and line C-D for BIKF to EINN.
3. Extend the perpendicular line(s) through each of the other tracks.
4. The point at which the perpendicular line intersects each track is the approximate CRITICAL POINT for that track.



ETOPS / LRN Route Policies

Any random route assigned by ATC may be accepted when using the 120, 138, 180 or 207-minute rules (207-North Pacific only). This is normally accomplished by data link from Dispatch to the flight and acknowledged by the crew.

North Atlantic

North Atlantic oceanic flights receive clearances while airborne (this may occur by datalink or radio VHF/HF contact), except for Shannon departures. (See SNN AIRPORT Page 10-10 for SNN procedures.) North Atlantic track clearance procedures are explained in detail on Atlantic Orientation Chart (H/L) 1 & 2. Current NAT clearance procedures are displayed on Enroute and Atlantic Orientation Charts and should be reviewed by the flight crew.

Note: It is the crew's responsibility to obtain the oceanic clearance.

Even though a 120, 138, or 180 ETOPS flight plan may not require a mid Atlantic alternate, whenever Keflavik, Iceland (BIKF/KEF) or Lajes, Azores (LPLA/TER) is forecast to be at or above alternate minimums, one or the other is often listed as an ETOPS alternate. This will often provide a closer alternate in the event of a diversion near the midpoint. Weather and NOTAMS should be provided for both of these airports regardless of their status on all North Atlantic flights.

In the event of a route change, crewmembers must be alert for the possibility that the flight plan routing may not match the published North American Routes (NAR) associated with the new clearance. **Additionally, it is the crew's responsibility to confirm with ATC that the clearance matches both the NAR common and the non-common routing (if published) from the inbound gateway to destination.** The terminology "cleared as filed" may not include a proper match with the correct NAR, and crews are cautioned to double check when issued a clearance using this phrase in connection with a North American Route. Provide ATC with a full route readback if there is any question.

Westbound aircraft entering Canadian Domestic Airspace from the Gander OCA and experiencing a communications failure while operating in accordance with an oceanic clearance not consistent with the flight plan route shall, at the termination of the cleared oceanic route (landfall); proceed directly to the next subsequent compulsory reporting point contained within the flight plan route which is beyond the flight plan landfall fix; and proceed on the flight plan route at the last assigned altitude or MEA, whichever is higher. (See Jeppesen ENROUTE Section.)

If pilots have not received their oceanic clearance prior to reaching the Shanwick OCA boundary, they must contact domestic ATC and request instructions to enable them to remain clear of oceanic airspace while awaiting such clearance.

This is not the case for other NAT OCAs into which a flight may enter while awaiting receipt of a delayed oceanic clearance. Pilots should always endeavor to obtain the oceanic clearance prior to entering these other NAT OCAs. However, if any difficulty is encountered, the pilot should not hold while awaiting clearance unless so directed by ATC.

When departing Europe on random routes, which lie south of the organized track system, Shanwick Oceanic will issue a clearance to the destination airport. However, their clearance authority does not extend to route segments which lie south of 36°N. Crewmembers must request confirmation of that portion of the route beyond 36°N through New York ARINC as part of the position report upon entering the New York Oceanic Control Area. In the event the crew is unable to obtain clearance past 36°N, **the flight is NOT expected to hold**. In that case, continue on the flight planned route and continue attempts to contact New York ARINC. The crew should also broadcast their intentions on 121.5.

On Eastbound flights to SNN, the route of flight is usually planned to exit the track at 15°W. If the clearance from Gander reads otherwise, specifically request clearance for the flight planned route as part of the position report at 20°W.

European routings use a system similar to the NAR routes. (See Jeppesen ENROUTE Section.) Clearances may be received utilizing terminology, “CLEARED STANDARD ROUTING” or “CLEARED PREFERRED ROUTING.” There are currently no official written definitions pertaining to the exact meaning when these terms are used, only interpretations provided by local ATC authorities. Therefore, caution is advised when such terminology is utilized.

It is the pilot's responsibility to confirm that the route specified on the Continental Flight Release and ICAO message conforms to the published route between the oceanic exit or entry point and the intended destination. When blanket terms such as “Standard,” “Preferred,” or “As Filed” are used, confirm that both the crew and ATC are in agreement as to the exact route to be flown, requesting a **full route clearance and readback** if in doubt.

Adjust ICAO Step

The default STEP value presented on the active cruise page is ICAO. In the event the flight is not ultimately flown at the optimum altitude, the crew should enter all predicted step climbs from the flight plan into the RTE LEGS page and then enter zero for the ICAO STEP value on the ACT CRZ page. This will allow for proper fuel and ETA predictions at the destination.

Coast Out Check

Prior to coast out and the loss of VHF nav aids reception, the crew should make a position accuracy check of the FMC. The Coast Out Check should be used to compare the FMC "Computer" generated bearing and distance with a manually or auto-tuned VOR "raw data" radial and DME.

To do the Coast Out Check:

- Select the Captains EFIS control panel VOR/ADF switch to the VOR position.
- Note the VOR being auto tuned.
- Enter the VOR identifier into the Captains FMC FIX page and note the bearing and distance displayed on Line 1.
- Compare the pointer and DME distance as displayed on the ND with the bearing and distance on the FIX page. Distance should agree within 4 NM and the bearings should agree within 8° at 50 NM DME and within 6° between 100 and 150 NM DME. If these values are exceeded, and the issues cannot be resolved by checking other nav aids with the FMC, do not enter ETOPS/LRN airspace.

Note: VOR bearings are also shown when the ND mode selector is in VOR position, and either or both VOR L or VOR R switches are selected. The VOR frequency and selected course are shown in the upper right-hand corner of the ND when operating in the **VOR** mode. Additionally, in the **VOR** mode, the ND has course / bearing centering and deviation presentation capability. VOR raw data bearing readout is also shown on the CDU NAVRAD page.

- Enter the applicable information on the COAST OUT CHECK box of plotting chart.

Note: Do not perform the COAST OUT CHECK until near the coast out point.

RVSM Altimeter Check

Prior to entering RVSM airspace, the crew will log the readings of the Captain's, First Officer's, and Standby altimeters on the RVSM ALTIMETER CHECK portion of the plotting chart. The Captain's and the First Officer's altimeter must agree within 200 feet of each other. The Standby altimeter is not required to be within 200 feet of either the Captain or the First Officer, but may be useful in resolving a major difference between the two primary altimeters. Failure to satisfy this requirement of the two primary altimeters agreeing within 200 feet will prohibit the aircraft from entering or remaining in RVSM airspace. If this occurs, notify ATC and coordinate an alternate FL or routing.

Within RVSM airspace, crosschecks between the primary altimeters should be made at each waypoint (minimum of once every hour). Recording of these crosschecks is not required.

Coast Out Check

ALL ACFT

RVSM ALTIMETER CHECK		
CAPTAIN	STANDBY	FIRST OFFICER
VOR FREQ _____ RADIAL _____ DME _____ FMC (Fix Page) Position Bearing _____ Dist _____		

Enroute Compass Check

Prior to coast out, the crew will conduct and record the ENROUTE COMPASS CHECK. Compare the Captain's, Standby, and First Officer's magnetic headings. Check the compass deviation card and apply appropriate corrections to the standby compass as required. Log these three values on the EN ROUTE COMPASS CHECK box of the plotting chart. They should all agree within approximately 5 degrees of one another. If they do not, further investigation and confirmation of the correct magnetic heading is required prior to entry into ETOPs airspace.

EN ROUTE COMPASS CHECK		
B727, B737, B777		
CAPTAIN	STANDBY	FIRST OFFICER

Display C-EEP and C-EXP

The C-EEP and the C-EXP should be displayed by placing the ICAO airport identifier for each of these Adequate airports on the fix pages with a /453 (one hour, single engine still air distance). The intersection of these green arcs and the magenta active course line reflect the C-EEP and C-EXP. This will normally be within a few miles of the latitude / longitude defining the C-EEP/C-EXP on the flight plan. It is important to note that the airports defining these points may not be the designated **Suitable** ETOPS alternate airports.

ETOPSOK Message

Prior to C-EEP an ETOPS enroute alternate airport weather / NOTAM update should be acquired. Normally this message is received by data link from Dispatch. The Dispatcher will request that receipt of the weather and continued suitability of the ETOPS alternates be acknowledged using the free text response "ETOPSOK." If the weather / NOTAM update is not received by 30 minutes prior to entry into ETOPS airspace, the crew should send a C-EEP estimate to remind the Dispatcher of the need for the information. If it is not possible to obtain an update prior to C-EEP, continue to fly as filed and attempt weather / NOTAM updates via all sources available.

HF Radio Check

The HF radios and SELCAL must be checked prior to the loss of VHF communications. The appropriate frequencies will be assigned enroute and may be found on the Jeppesen Orientation Chart.

Transoceanic communications are conducted primarily by HF radio. The following checks will ensure that the HF radios are functioning properly.

Prior to loss of VHF communications:

- Select the appropriate HF frequency from Jeppesen or as assigned by ATC on both radios.
- Key microphone and listen for the tone.
- Contact appropriate agency for HF and SELCAL check.
- The SELCAL decoder monitors for audio tones. If the tones received are the same as the SELCAL code of the aircraft, the decoder sends a signal which will give the following indications:
 - HI/LO chime
 - Com message – SELCAL
 - **CALL** light on the audio control panel for the radio that received the SELCAL code

If the SELCAL decoder is inoperative, a constant listening watch will be maintained on the primary HF frequency.

Due to the use of one common antenna, both transmitters may not be used simultaneously – blanking will result.

If a valid SELCAL check is received on either HF radio, the HF radios need not be monitored during flight.

ENROUTE ETOPS

The PF, using the MASTER flight plan, will maintain a log of actual times and fuel burn at each waypoint. Additionally, log the appropriate mid-point MET data on the MFP, if required.

Track / Route Mach Restrictions

When a Mach restriction is issued as part of an oceanic clearance, the flight will be flown at that speed while on the Track / Route. This speed will also be maintained beyond the Track / Route until the aircraft is in radar contact with ATC or has otherwise received clearance to change speeds. Set the required Mach on the ACT CRZ page (2L) as specified in the ATC clearance. If no Mach assignment or restriction applies, continue to use the Mach number specified in the flight plan. Remember aircraft spacing on the Track / Route is based on precise aircraft speed control.

LNAV / VNAV Operation

All crewmembers should ensure that the aircraft is following the intended route of flight.

After passing the entry point and at each subsequent waypoint, confirm that LNAV and VNAV are engaged and the aircraft is properly tracking the desired course.

Caution: Failure to ensure LNAV is engaged is a major source of gross navigation errors. This is easy to overlook after having utilized another roll mode, such as heading select, for a weather deviation.

Enroute VHF

On flights operating outside of VHF coverage, a suggested method of configuring the VHF radios is as follows:

Left VHF 121.5 Guard

Right VHF 123.45 or appropriate Air-to-Air common

Current frequencies may be found on the Jeppesen charts for the intended area of operation.

Loss of Communications

In the event of lost HF communications while on track, relay position reports through other aircraft or ground stations on the VHF frequencies found on the appropriate enroute orientation chart. If unable to make contact on these frequencies, use 121.5 MHz. In the event of lost communications, follow the most recently issued ATC clearance. Detailed lost communications procedures are found on the Orientation charts.

Note: The crew may consider the use of SATCOM to reach an ATC facility or SOCC for a frequency assignment.

Transponder Settings

Unless otherwise directed by ATC, or in cases of emergency or radio failure, transponder codes will be set as follows:

- ATLANTIC: Code 2000 (last assigned code will be maintained while in domestic airspace). A rule of thumb is to add 30 minutes to the ATA of the first waypoint on the NAT Track. This would be the earliest time to change the code to 2000.
- NOPAC: When operating West of 164°E, transponders should be set to Mode A Code 2000. When East of 164°E, a discrete code may be assigned which should be maintained unless otherwise advised by ATC. If no discrete code is assigned, transponders should be set to Code 2000.
- MIDPAC: Code 2000 after “Cleared to enroute frequency” by ATC.
- POLAR: Code 2000 beyond radar coverage.
- GUAM: When approaching within 250 NM of the airport, Code 2100.

FIR Boundary Crossing

When approaching an FIR boundary, radio contact should be made with the next controlling authority 10 minutes prior. A listening watch should then be maintained on both frequencies until over the boundary and released by the previous controller. If unable to contact the appropriate control center on VHF or HF, relay position through ARINC, or a nearby aircraft. Check the Jeppesen chart / Enroute section for specific FIR procedures.

ETOPS Enroute Alternate Procedures

During the course of the flight, the crew should be informed of any significant changes in conditions at designated enroute alternates (by Dispatch) via SELCAL or ACARS data link.

The suitability of an enroute ETOPS alternate airport for an (actual) in-flight diversion is based on a determination that the airport remains suitable for the circumstances, and that the weather and field conditions permit an instrument approach to be initiated and a landing completed.

Dispatch alternate minima **do not** apply once the dispatch release is signed. The determination of enroute suitability is based on the **landing weather minima**, weather conditions, navigation and communication facilities, ATC services, runway condition, airport safety facilities and services, and circumstances that created the need to divert.

Note: If any conditions are identified (such as weather forecast below landing minimum) which would preclude safe approach and landing, an acceptable alternate should be selected where a safe approach and landing can be made. If possible, a new ETOPS enroute alternate should be selected which is within the time limitation of the flight's release. It should always represent the best option available; however, the new alternate is **not required** to be within the dispatch time limitation except for 180 / 207 minute ETOPS Ops. The maximum diversion time to the selected alternate should not exceed 180 minutes for NATL or 207 minutes for NOPAC. If a new alternate cannot be found, the flight may be continued and the search for a suitable alternate continued.

There are many resources available to the pilot for obtaining weather updates to verify the continued suitability of the weather at the ETOPS, redispach, or destination alternates. These include VOLMET broadcasts, AIRINC HF phone patch, ACARS data link, and SATCOM.

Configuring the ALTERNATE Page

On the ALTN page, identify and manually enter the two closest designated ETOPS enroute alternates. This allows the remaining two displayed alternate positions to reflect the closest airports as they change during the flight. As the flight progresses with CRITICAL POINT passage, the appropriate designated ETOPS alternates should be changed to reflect the two closest ETOPS alternates. Once entered, the alternates sequence in ETA order and are immediately available should a diversion become necessary.

North Pacific / Mid Pacific

Continental Airlines is only authorized to dispatch the B777 aircraft under 207 minute ETOPS authority for operations that traverse the North Pacific (NOPAC) area of operation.

If Eareckson/Shemya AFS (PASY/SYA) and Petropavlovsk Russia (UHPP/PKC) are not designated as ETOPS alternates their weather and NOTAMS should still be provided, given the close proximity of these two airports on all the tracks / routes to and from Japan. The crew should be aware of the status of these two airfields when making a divert decision resulting from a time sensitive major inflight emergency.

Radar observed navigational errors are monitored and reported. Lateral deviations of 20 NM are recorded and those of 25 NM or more are investigated to determine causative factors. Pilots should understand that these reports are only intended to provide data for analytically detecting any significant changes in the navigational performance, which may require corrective action, and to provide a basis for future refinements of the system as performance improves.

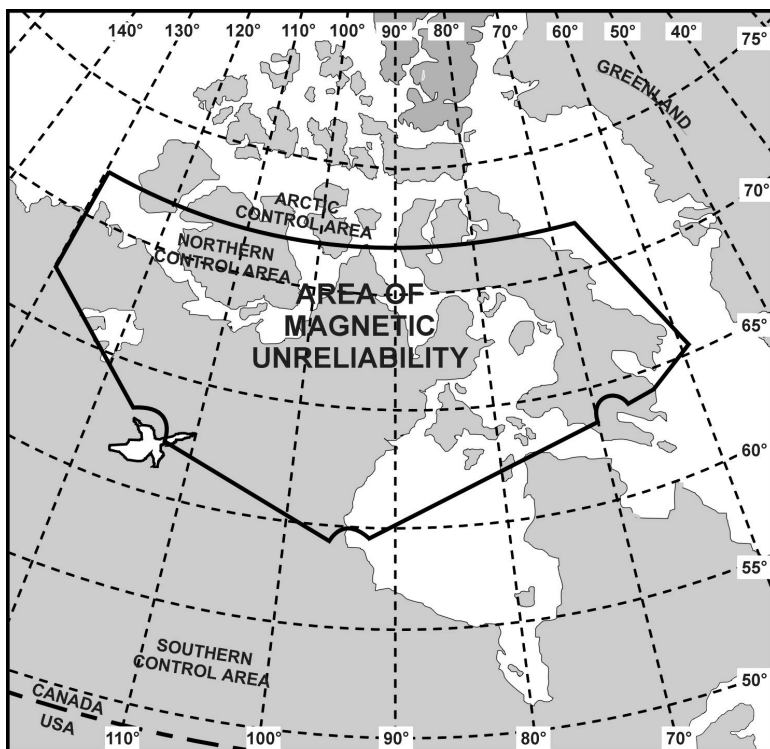
Be advised that the above wording does not rule out the possibility of a violation being filed for errors of 25 miles or more.

Northern Control Area / Polar Region

Canadian authorities have designated the entire Northern Control Area (NCA) as an area of magnetic unreliability (AMU). The limits of the NCA are depicted on the CA (HI) enroute charts.

Continental B777s are authorized to conduct operations within the NCA. Continental is not authorized to conduct instrument approaches in the NCA and no alternate airports are designated in this area.

Also refer to the IFOG Manual SECTION 6, POLAR, RUSSIA & FAR EAST for additional information on operations in these regions.



Note: The ND displays Magnetic Course (MC), Magnetic Heading (MH) and Magnetic Wind (MW) with the HDG REF switch in NORM. The ND compass rose may be referenced to magnetic north or true north. The HDG REF switch is used to manually select true reference. With the heading reference switch in NORM the compass display is automatically referenced to true north when the aircraft is north of 82° north latitude, south of 82° south latitude, or near the magnetic poles. A flashing white box around the word **TRU** on the ND annunciates automatic switching to a true reference. A true heading reference may be selected with the HDG REF switch inside or outside the polar region. The ND shows a green box around the word **MAG** to annunciate the change back to magnetic reference. If the heading reference is **TRU** in the descent the ND shows an amber box around the word **TRU**. If the HDG REF switch is moved to **TRUE**, the CDU displays true track, true wind, and true heading.

Note: When operating the autopilot in the polar region in other than LNAV, the **TRUE** position on the HDG REF switch must be selected.

Note: When operating in the polar region with the ND PLAN mode selected, the aircraft position symbol does not display.

Magnetic Field Horizontal Component

Conventional compass systems detect only the horizontal component of the earth's magnetic field. This component may be nonexistent or nearly nonexistent within approximately 1000 miles of the earth's magnetic poles.

Rapid Variation Changes

Close to the earth's magnetic poles, there may be dramatic changes in magnetic variation over relatively short distances.

Meridian Convergence

The earth's meridians converge to a single point at 90 degrees latitude (the earth's geographic poles). The convergence effect as it relates to true-referenced great circle navigation at high latitudes can result in rapid and substantial changes in true course and heading over relatively short distances. For example, flying east from 85N-100W to 85N-60W, two points at the same latitude, the initial true course is 070 degrees; the inbound course at 85N-60W is 110 degrees, a difference of 40 degrees over a distance of only 207 miles. (The average true course is 90 degrees.)

Another effect of convergence is that a small position error at high latitudes can result in a very large error in determining the true course and bearing required for safe navigation.

Convergence is not a factor on true north-south routes and on east-west routes at the equator (where there is no convergence). It becomes more apparent with increasing latitude on east-west routes.

VOR Reference

VORs in the NCA are referenced to true north as indicated on the CA enroute charts. Therefore, VOR courses observed on flight deck instruments are true courses.

When flying a great circle to or from a VOR facility, the pilot may note a substantial difference between the VOR course and the track required to maintain that course centerline. This is the effect of convergence. It can be dramatic on east-west routes and increases as the distance from the VOR increases. In the example used in Meridian Convergence, flying from 85N-100W to a VOR situated at 85N-60W, the selected VOR radial would be 110 and the true track required at 85N-100W to maintain the VOR course centerline would be 070 degrees. (At the midpoint to the VOR, the required true track would be 090 degrees.)

VOR/ADF Bearing Differences

To reconcile the differences between observed VOR radials and ADF bearings, it may be helpful to recall that VOR radials are measured at the VOR station and, in the NCA, are referenced to true north. ADF bearings are measured at the aircraft using the aircraft's compass system. VOR course and the ADF bearing information derived from co-located VOR/NDB facilities may differ depending on the amount of variation at the aircraft and the effect of convergence between the aircraft and the VOR station.

NCA / SCA Routes

A system of 4 tracks in the Northern Control Area (NCA) and 5 tracks in the Southern Control Area (SCA) have been designated to accommodate traffic between North America and Europe. They are designated NCA routes Alpha through Delta and SCA routes Golf through Kilo. These routes are depicted on the CA (HI) enroute charts.

For position reporting on the NCA and SCA tracks, positions are expressed in terms of the track designator (Alpha, Bravo, etc.) and the longitude at the reporting fix. Latitude is not reported.

Waypoint Procedures

As a waypoint is approached (approximately 30NM), there are several actions that must be performed in a relatively short period of time. With good crew coordination each may be accomplished properly. The position report is the activity that is least time constrained but, due to frequency congestion, usually causes the most difficulty.

The **first priority** must be the safe and accurate navigation of the aircraft; and then the preparation, checking, transmission, and monitoring of the position report. To accomplish this the crew must work with two different documents as they approach a waypoint:

- The Master Flight Plan
- The Plotting Chart

The Captain may reassign the PF vs. PM waypoint procedure duties as desired.

FMC/Position Accuracy Check

The accuracy check will be performed at each waypoint during LRN operations. This check verifies accuracy of the FMC position.

To perform the Position Accuracy Check:

Select POS REF 2/3 and select the bearing / distance prompt (6R) and, if necessary, log on the plotting chart adjacent to the waypoint coordinates:

- The FMC Position Source (1L)
- The **INERTIAL** Δ value (2L)
- The **RNP/ACTUAL** values (5L).

It is not necessary to log this data on the plotting chart as long as all three of the following conditions are met:

- GPS is updating the FMC, and
- **INERTIAL** Δ value is equal to 4.0 NM or less, and
- **ACTUAL** value is less than **RNP**.

If any of the three conditions are not met, record all three parameters on the plotting chart adjacent to the waypoint (see the completed plotting chart for an example).

POS REF		2/3
1L	FMC (GPS)	UPDATE
	N50°00.0 W050°00.0	ARM>
2L	INERTIAL	ACTUAL 5.70
	150°/3.9NM	
3L	GPS	ACTUAL 0.12
	000°/0.0NM	
4L	RADIO	ACTUAL
5L	RNP/ACTUAL	DME DME
	4.00 / 0.12	
6L	<INDEX	LAT / LON>

Approaching A Waypoint

The PF checks the next waypoint (WPT) coordinates and identifier from the MASTER Flight Plan (MFP) and ensures that the magnetic course (M/C), distance (DIST), and time on the FMC agree with the MFP. Providing these match, the PF places a single slash mark through the circled waypoint. If any of these parameters are in significant disagreement, immediately investigate, determine the cause, and take corrective action to ensure the FMC data reflects the correct routing. For a very short period of time there are two waypoints on the flight plan with single slash marks. This is resolved with the actual waypoint passage when the “current” position waypoint gets a second slash mark. Next, for reference, set the heading selector bug on the MCP to the next **outbound magnetic heading** as read from the M/H column of the MFP. **Do not engage heading select or heading hold.**

The PM performs the FMC Position Accuracy Check as described above and, in addition, cross checks all altimeters to fulfill RVSM altimetry requirements.

Fix Page

The PM enters the approaching waypoint ETA plus 10 minutes on the FIX page PRED ETA position to create a green circle on the active route to serve as a reminder to accomplish a position verification.

Example (eastbound from N51W050 to N52W040): After passing N51W050 note the time of passage (ATA) on the POS REPORT page. Select the FIX page. Enter the ATA + 10 minutes (4 digits plus Z) at (6R) in the PRED ETA-ALT position. A green circle with the time entered appears on the magenta course line 10 minutes past N51W050 as a reminder of when to do a position verification.

At The Waypoint

Both the PF and the PM **will confirm** that the aircraft turns to the correct outbound heading (approximating the previously set heading bug), and tracks the correct outbound course. **Ensure LNAV and VNAV are engaged.**

After Waypoint Passage

After waypoint passage the PF:

- Places a second slash on the MFP through the just passed waypoint,
- Logs the ATA on the MFP and compares with the ETA for that waypoint,
- Logs the fuel remaining at the waypoint (from POS REPORT page),
- Enters, on FIX page 2/2, the ETA for the next waypoint in the PRED ETA-ALT position (6R). A green circle with the time entered appears over the next waypoint as a visual ETA/ATA comparison (EFIS DATA display selected).
ATC update is required if times differ by 3 minutes or more.

Note the OAT and wind, and if significantly different from the master flight plan, record and notify Dispatch. Any significant discrepancy needs to be resolved by further investigation of the MFP and the FMC.

The PF will also record the mid MET data on the MFP for all legs, as required.

There is normally a relatively small difference between the **calculated** fuel onboard (as determined by the FMC / fuel flow inputs and displayed on the POS REPORT page) and the **sensed** fuel (as determined by the fuel quantity indicating system and displayed on the EICAS). This difference normally does not exceed 3000 lbs, and is the result of small inaccuracies in the sensors, changes in fuel density due to cold soaking, or prolonged use of the APU.

Unless there is substantial evidence to indicate a gross error in the calculated fuel value it should not be altered, and this is the value that should be logged on the MFP.

The following example summarizes the enroute waypoint confirmation procedure.

CYMON	N49 43.0 W055 00.0	44	52	00	617	02.02	1.14	0175
	37 074 073 053 052 26016 P014	486	500	2102	04.13			0752
RMNG WGT-	4727 ISA- P04 KIAS- 274	MACH-	.839					
N52W030	N51 00.0 W050 00.0	44	52	00	207	02.26	0.24	0056
	37 091 090 068 066 27034 P030	486	516	1895	03.49			0696
RMNG WGT-	4671 ISA- P04 KIAS- 274	MACH-	.840					
N52W040	N52 00.0 W040 00.0	43	53	01	379	03.11	0.45	0101
	37 102 097 081 075 32056 P023	486	509	1516	03.04			0595
RMNG WGT-	4570 ISA- P04 KIAS- 274	MACH-	.840					
N52W030	N52 00.0 W030 00.0	37	50	04	371	03.55	0.44	0101
	37 108 100 090 081 35081 P014	488	502	1145	02.20			0494
RMNG WGT-	4469 ISA- P06 KIAS- 274	MACH-	.840					
N52W020	N52 00.0 W020 00.0	32	47	04	370	04.37	0.42	0094
	37 104 105 090 091 26039 P039	492	531	0775	01.38			0400
RMNG WGT-	4375 ISA- P09 KIAS- 274	MACH-	.840					
LIMRI	N52 00.0 W015 00.0	35	54	03	186	04.58	0.21	0045
	37 100 103 090 093 25055 P050	484	534	0589	01.17			0355
RMNG WGT-	4330 ISA- P02 KIAS- 274	MACH-	.840					
DOLIP	N52 00.0 W012 00.0	36	56	01	111	05.11	0.13	0028
	37 098 101 090 092 24045 P040	483	523	0478	01.04			0327
RMNG WGT-	4302 ISA- P01 KIAS- 274	MACH-	.840					
ALTITUDE CHANGE TO FL 390 - 0000 MILES / 00.00 MINUTES AFTER - DOLIP								

- ① ~~N51W050~~ = After waypoint passage.
- ② ~~N52W040~~ = Waypoint ID at N5200.0 W04000.0 coordinates rechecked enroute, with time, distance, and desired track to this fix verified
- ③ N52W030 = Waypoint ID at N5200.0 W03000.0 coordinates verified during predeparture flight deck prep

Position Report

After waypoint passage the PM will make the position report as read from the POS REPORT page of the FMC [PROGRESS 1/3 and then select 6L]. Some position reports may not be required during Automatic Dependant Surveillance (ADS) operations. Consult the most current information from Jeppesen charts, Training Bulletins and the Flight Manual as this program evolves.

COA028 POS REPORT				
1L	POS N51W050	ATA 0332	ALT FL370	1R
2L	EST N52W040	ETA 0414		2R
3L	NEXT N52W030			3R
4L	TEMP -50°C	WIND 230°/105KT		4R
5L		POS FUEL 77.4		5R
6L	<PROGRESS		REPORT>	6R

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A Position Report will be given over all Track / Route compulsory-reporting points, normally by the PM. **Both the transmission and the readback** should be monitored by the PF to ensure that both the flight crew and the controlling agency understand information, clearances, etc. The PF should refer to the POS REPORT page (PROGRESS 6L) to confirm the accuracy of position reports.

If a route change is received shortly before crossing a fix, ATC will expect a position report over that fix.

When transmitting a Position Report, it is not necessary to clutter the data with its specific title, since the radio operator is copying the report on a form that follows the identical order. For example, when reporting a wind of 250/37, the transmission would be “two five zero, diagonal three seven,” as opposed to “Wind - two five zero degrees, slash, three seven knots.” The correct terminology for 83.5 pounds of fuel remaining would be, “eight three decimal five,” as opposed to “Fuel, eighty three point five pounds.”

<u>EXAMPLE</u>	
ATC Addressee	“GANDER RADIO”
Aircraft call sign followed by saying, “Position”	“CONTINENTAL 28 POSITION”
<i>AFTER ACKNOWLEDGMENT BY THE RECEIVING STATION:</i>	
Call Sign. Waypoint name (POS) or LAT, then LON	“CONTINENTAL 028, 51 NORTH 050 WEST”
Zulu Time (ATA) over waypoint	“0332”
Flight Level (ALT)	“FLIGHT LEVEL 370”
Name of the estimated (EST) waypoint on assigned route.	“ESTIMATING 52 NORTH 040 WEST”
Estimated (ETA) Zulu time of arrival at waypoint.	“0414”
Name of (NEXT) subsequent position and word “next.”	“52 NORTH 030 WEST NEXT”
Fuel remaining (POS FUEL) Lbs.	“77 DECIMAL 4”
<i>AND WHEN DESIGNATED BY THE LETTER “M” NEXT TO THE WAYPOINT OR WHEN REQUIRED ON A RANDOM ROUTE OR WHEN ASSIGNED TO BE A “MET” AIRCRAFT (REF AT-1 Panel 2)</i>	
Outside Air Temperature (TEMP) SAT °C	“MINUS 50”
(WIND) To nearest degree (true) and knot	“230 DIAGONAL 105”
Significant weather – turbulence, icing, etc.	“MODERATE TURBULENCE LAST TEN MINUTES”
<i>FOR NATL OPERATIONS ONLY, THE MID MET (REF AT-1 Panel 2)</i>	
Mid position of previous leg	“4930 NORTH 055 WEST”
Mid position outside Air Temperature (TEMP) SAT °C	“MINUS 52”
Mid position (WIND) to nearest degree (true) and knot	“245 DIAGONAL 100”
Mid position significant weather – turbulence, icing, etc.	“LIGHT ICING”

North Atlantic Position Reporting Procedures

East / Westbound flights:

- South of Latitude 70N at 10° Longitude intervals between 0° and 70° W.
- North of Latitude 70N at 20° Longitude intervals between 0° and 60° W.

North / Southbound flights:

- At 5° Latitude intervals Longitude in degrees and minutes.

The distance between reporting points shall, as far as possible, not exceed one-hour flight time.

When operating at a distance of 60 NM or less from the common boundary with an adjacent Oceanic Area, position reports shall also be copied to the center serving the adjacent area.

Pacific Position Reporting Procedures

For East / Westbound or North / Southbound flights the requirements are the same.

- Every 10 degrees. In no case will position reports be at intervals in excess of one hour and twenty minutes (1:20). In other words, every 10 degrees or 1:20 hours, whichever comes first.
- Every 5 degrees if the time between waypoints is more than one hour and twenty minutes.

Revised ETAs

In most theaters of operation, it is a requirement to send a revised estimate if the original ETA will be three (3) minutes or more in error. However, the NOPAC and Bermuda theaters have different ETA limitations. To standardize and simplify procedures, it is company policy to submit a revised estimate whenever an ETA is three (3) minutes or more in error.

Position Verification

As the aircraft approaches the green circle on the FMC active route, the PM selects the 10-mile scale on the ND and verifies the aircraft symbol is on the FMC active route line. In addition, select PROGRESS page 2/2 and observe the XTK error at 2L. This shows the distance the aircraft is left or right of the active route. Reconfirm that LNAV and VNAV are engaged.

- Recording the post position coordinates on the plotting chart is not required if:
 - GPS is updating the FMC
 - Position accuracy check was within described limits, and
 - The above position verification shows the aircraft to be on course.

Plotting Chart & Post Position Plot (PPP)

The plotting chart is used for flight following, confirmation of position, and confirmation of position reporting accuracy. The chart also serves as a backup tool in case of total navigation system failure.

If any of the position verifications conditions are not met, post position plotting is required. The PM will record a PPP on the plotting chart approximately 10 minutes or approximately 2 degrees after waypoint passage.

Record the coordinates of the PPP on the plotting chart using the following procedures:

- Scratchpad the FMC position on POS REF page 2/3 when passing over or near the green circle.
- Plot LONGITUDE position first and then LATITUDE on the chart.
- Record the PPP Latitude and Longitude as well as the Zulu time on the plotting chart. (See completed plotting chart for an example.)

Caution: Any plot not coinciding within 1/8 of an inch of the track / route must be resolved immediately.

Note: **It is never acceptable to insert an along track fix 2 degrees from the waypoint and then transcribe the coordinates onto the plotting chart as a valid PPP.** This is only a prediction of where a particular latitude or longitude will intersect the active route, and to do this defeats the primary purpose of the PPP concept. It does not define the actual aircraft position at the approximate 10 minute / 2 degree point, and does not provide positive confirmation of the relationship of the actual aircraft position and the desired track. As an example, this illegal procedure would not detect a flight where LNAV had been inadvertently disengaged, there had been a MAP shift, or any number of other anomalies. The only fool proof method is to plot the current aircraft position (FMC POS) at the prescribed time during the PPP procedure.

Completed Plotting Chart

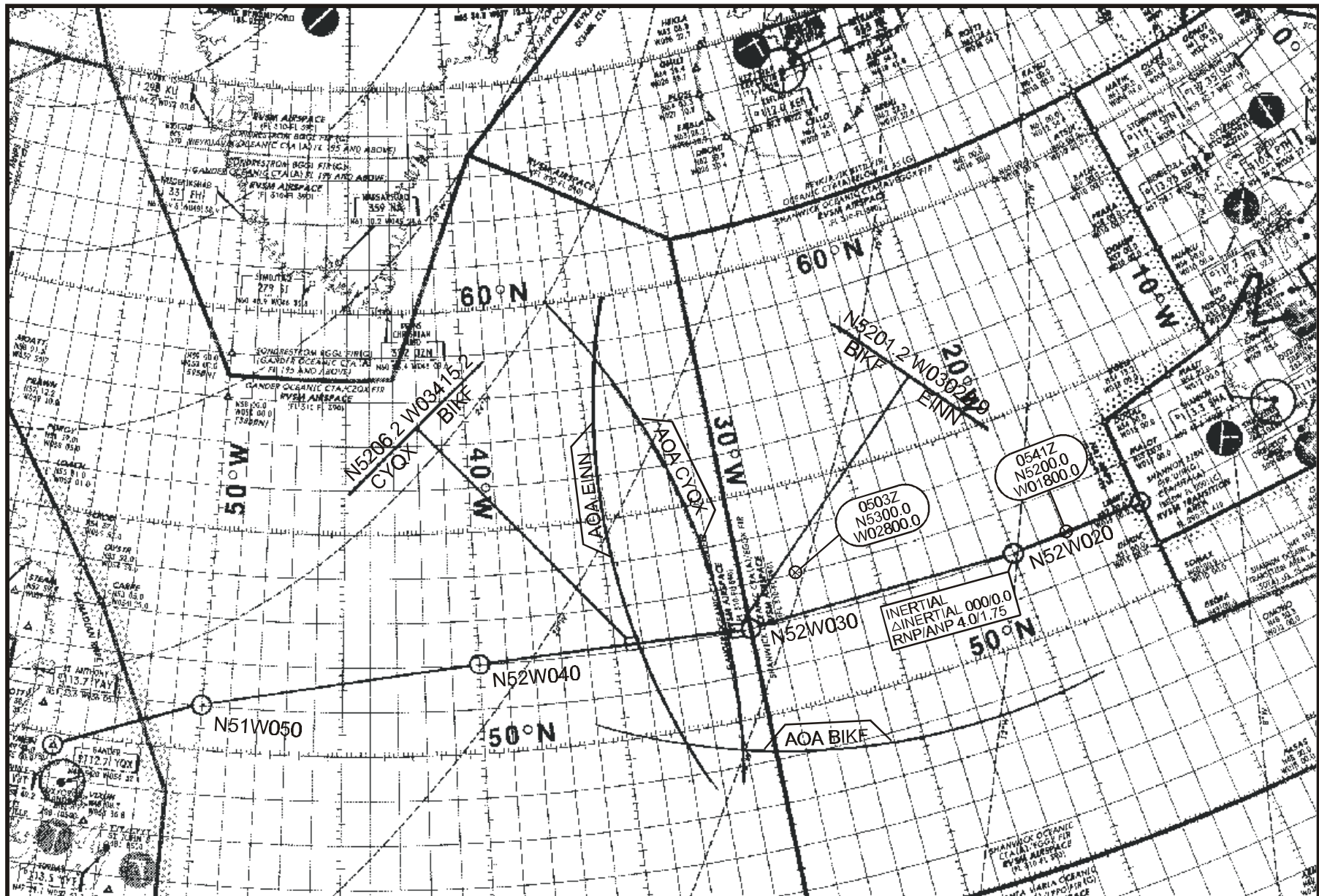
The following figure illustrates how a chart might appear after completion of the flight where plotting is required. Note the inclusion of the following data, which has been plotted or entered while enroute:

- Position Accuracy Check at each of the waypoints. (It is not necessary to log this data on the plotting chart as long as all three of the following conditions are met: GPS is updating the FMC, inertial Δ value is 4.0 NM or less, and ANP does not exceed RNP.)
- Post Position Plot (PPP) approximately 10 minutes after each waypoint (if required).

Note: The PPP plot at 028 degrees West shows an off-course position. This could identify a navigational error, which should be investigated immediately and corrected as necessary. The data recorded at 20 degrees West reflects the loss of GPS updating to the FMC and necessity to log Position Accuracy Check data.

The plotting chart is also useful in the event that the crew has been assigned an alternate track and subsequently has a navigation system failure. In this case, the Magnetic Headings (MH) listed in the Continental Flight Plan may not be valid and the crew would have to measure Magnetic Course (MC) and/or True Course (TC), and distance on the plotting chart. Remember to measure Magnetic Courses (MC) or True Courses (TC) at the Mid Point Latitude and then apply variation and compass deviation. Then, using wind information from the best source available, apply drift correction to calculate a Magnetic Heading.

INTENTIONALLY LEFT BLANK



INTENTIONALLY LEFT BLANK

Weather Deviation From Track / Route

If the aircraft is required to deviate from track to avoid weather and prior clearance cannot be obtained, an air traffic control clearance shall be obtained at the earliest possible time. If ATC approval cannot immediately be obtained broadcast your intentions to other aircraft in the area on the air-to-air common frequency and on 121.5MHz if the situation warrants.

Specific weather deviation instructions and/or track deviation procedures, if applicable, may be found on the appropriate Jeppesen Enroute chart, Orientation chart, or in the Jeppesen Enroute section.

Caution: A common cause of gross navigational errors is failure to reengage LNAV after using the heading select mode to avoid weather.

Wake Vortex Encounters Within RVSM Airspace

When flying within NAT MNPS Airspace (but **not** in adjacent domestic airspace RVSM transition areas), if considered necessary, the pilot may offset from cleared track by up to a maximum of 2 nm (upwind) in order to alleviate the effects of wake turbulence. ATC should be advised of this action and the aircraft should be returned to cleared track as soon as the situation allows. It must be noted, however, that such a maneuver is considered a contingency procedure and ATC will not issue a clearance for any such lateral offset.

- The pilot should establish contact with other aircraft, if possible, on the appropriate VHF air-to-air frequency (123.45), and
- One or both aircraft may initiate lateral offset(s) not to exceed 2 NM from the assigned track, provided that:
 1. As soon as practicable to do so, the offsetting aircraft notify ATC that temporary lateral offset action has been taken and specify the reason for doing so, and
 2. The offsetting aircraft notify ATC when re-established on assigned route or track.

RVSM

For RVSM procedures refer to the applicable Jeppesen Orientation chart and Continental Flight Operations Manual.

COAST IN AND ARRIVAL

Coast In Cross Check

When in range of reliable VOR/DME signals, check the accuracy of the FMC units by comparison of VOR radials and DME distances and log on the plotting chart. The method is identical to the COAST OUT CHECK. The COAST IN CHECK is not required if the aircraft's position is verified by radar prior to the reception of ground based nav aids.

As The Coast-In Fix Is Approached

Confirm the remaining or domestic routing and ensure it is properly loaded into the FMC. Verify the proper transponder setting.

Normally the FMC will be utilizing GPS, however, note that the ND and POS REF Page 2/3 will indicate the VOR stations in use and whether DME-DME updating of the ADIRU is occurring. The accuracy of GPS should minimize the need; however, if necessary, the FMC will update rapidly when within radio updating range of VOR/DME signals. The course line on the ND may shift left or right in several small increments as the FMC position is updated.

APU Reliability Program

Continental's ETOPS certificate requires that we maintain an APU "In-Flight Start" program. When requested by Maintenance via voice or data link, the following procedure should be initiated prior to top of descent (TOD).

Flight crews should attempt to start the APU in-flight a maximum of three (3) times in order to achieve a successful start.

After a successful start:

- Allow the APU to run for a minimum of 5 minutes.
- It is not necessary to acknowledge the request or to down link the APU data. It is, however, required that the following information be recorded in the logbook:
 1. APU reliability cold start
 2. SAT in degrees centigrade
 3. Flight level
 4. Number of start attempts
 5. Successful / unsuccessful.

If the APU fails to start after two attempts, make a third attempt during descent before reaching FL210.

If the APU fails to start on the ground also note that in the logbook.

Transition Level Check

The IN RANGE checklist should be accomplished at 18,000 feet. At the transition level, confirm the proper altimeter setting has been selected. The APPROACH checklist is the last opportunity to catch lower than normal transition levels.

Holding

Refer to the Jeppesen Air Traffic Control section for differences to ICAO procedures, including holding speeds, for the destination country.

POST FLIGHT

Logbook Entry –Drift Rates

To ensure the reliability of the ADIRU record the inertial monitor data into the logbook as shown below.

- On the CDU select INIT REF then INDEX (6L)
- Select MAINT (6R)
- Select INTERNAL MONITOR (2L)

REQUIRED FLIGHT CREW ENTRY											
R'qrd A/C Checks Date _____		Date _____		Date _____		Date _____					
Flt # <u>28</u>	Flt # _____	Flt # _____	Flt # _____	Flt # _____	Flt # _____	Flt # _____	Flt # _____				
FOB <u>28.3</u>	FOB _____	FOB _____	FOB _____	FOB _____	FOB _____	FOB _____	FOB _____				
City <u>LGA</u>	City _____	City _____	City _____	City _____	City _____	City _____	City _____				
Date <u>7/1</u>	Date _____	Date _____	Date _____	Date _____	Date _____	Date _____	Date _____				
EX'D 2 HRS. <input type="checkbox"/>	EX'D 2 HRS. <input type="checkbox"/>	EX'D 2 HRS. <input type="checkbox"/>	EX'D 2 HRS. <input type="checkbox"/>	EX'D 2 HRS. <input type="checkbox"/>	EX'D 2 HRS. <input type="checkbox"/>	EX'D 2 HRS. <input type="checkbox"/>	EX'D 2 HRS. <input type="checkbox"/>				
INS/IRS DRIFT RATE											
#1 L	#3 C	#2 R	#1 L	#3 C	#2 R	#1 L	#3 C	#2 R	#1 L	#3 C	#2 R
DRIFT NM/HR <u>0.1</u>	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
G/S KTS _____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
DIST NM _____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____

Flight Envelope And Contents

At the completion of an ETOPS/LRN flight, Master Flight Plans, Plotting Charts, and Fuel Slips must be placed in a Flight Envelope and returned to the Chief Pilot Office at the conclusion of the pairing. Weather, NOTAMS and other pertinent flight plan information is electronically stored by CAL for 3 months.

The Flight Envelope will be retained for a period of 3 months for the purpose of documenting position reports, international navigation procedures and fuel reconciliation procedures.

NON-NORMAL PROCEDURES**EMERGENCY PROCEDURES ON TRACK / ROUTE****Deviations From Track Or Altitude**

The flight crew should notify ATC in a timely manner of contingencies affecting the aircraft's ability to maintain flight level, track, or Mach, and coordinate a plan of action.

If an aircraft is unable to continue flight in accordance with its ATC clearance a revised clearance shall be obtained, whenever possible, prior to initiating any action. This shall also apply to aircraft unable to maintain the accuracy of navigation required for MNPS and RVSM operations to maintain safe separation between aircraft. Make the radio call for urgency (PAN-PAN-PAN) or distress / grave danger (MAYDAY-MAYDAY-MAYDAY) as appropriate. Subsequent ATC action with respect to that aircraft shall be based on the intentions of the pilot and the over-all air traffic situation.

Remember that Oceanic control facilities are relay stations for ATC agencies. Request direct contact with an ATC controller in an emergency situation.

In the event that flight crews encounter situations causing them to be unsure of the vertical or lateral position of the aircraft within ATC airspace, or the aircraft must deviate from the cleared flight level, route or Mach, the following procedure should be accomplished in an expeditious manner:

- Unless the nature of the contingency dictates otherwise, the crew should advise ATC as soon as possible of the situation and, if possible, request an ATC clearance before deviating from the assigned route, flight level or Mach. If such a clearance is not readily available, the crew should alert adjacent aircraft by making maximum use of aircraft lighting and broadcasting position, flight level, and intentions on 121.5 or the appropriate Air-to-Air frequency.

- If a revised ATC clearance cannot be obtained in a timely manner and actions are required to avoid potential conflict with other aircraft, terrain or severe weather, the aircraft should be flown at an altitude and/or track where other aircraft are least likely to be encountered:
 - The crew may offset half the lateral distance between routes or tracks (Pacific and Caribbean-25 nm, North Atlantic-30nm). Whenever possible, initiate this by turning 90° left or right (appropriate for known proximity traffic, terrain clearance, or diversion airport direction).
 - If able to maintain assigned altitude, climb or descend 500 ft.
 - If unable to maintain assigned altitude, start descent while turning to acquire the offset route. Once able to maintain level flight select an altitude that differs by 500 ft. from those normally used.
- When executing a contingency maneuver the crew should:
 - Maintain maximum watch for conflicting traffic.
 - Continue to alert other aircraft on 121.5 or appropriate air-to-air frequency.
 - Utilize maximum aircraft external lighting.
 - If possible, maintain the offset track and/or altitude until an amended ATC clearance is obtained, or the aircraft is clear of the track or routing structures.
 - If unable to maintain the offset track and/or altitude before an amended ATC clearance is obtained, take action to advise other aircraft of position and intentions.
 - Declare an emergency.

Engine Out Driftdown Speed (One Engine Operation)

Selection of the **ENG OUT>** prompt (5R) on the ACT ECON CRZ Page 2/3, results in engine-out best gradient speed schedules, performance predictions, and guidance. The **CO SPD** prompt (5L) on the ACT E/O D/D Page 2/3, may be selected for the CAL speed schedule of M.84/329 KIAS.

Additionally, any Mach / Speed combination may be typed in the scratchpad and then placed in (2L).

ACT E O D / D		2/3
1L	CRZ ALT	1R
2L	EO SPD	2R
3L	TO 15500	3R
4L	1420Z/ 211NM	4R
	EGLL ETA/FUEL	
	2343Z/ 27.9	
	STEP SIZE	
	OPT MAX	
5L	ICAO	5R
	FL206 FL206	
6L	<CO SPD	6R
	ALL ENG>	
	LRC>	

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Although the dispatch release, time, and critical fuel calculations are predicated on the use of the M.84/329 KIAS profile in the event of an engine failure in the ETOPS environment, the crew has the flexibility of operating at any speed between the minimum maneuvering speed and maximum certified operating speed as the situation warrants. It is important to consider the significant differences in speed, time and fuel between the ECON (optimum) E/O, LRC E/O and the Company E/O of M.84/329 KIAS.

When selecting an appropriate diversion speed, the following factors should be taken into consideration:

- **Initial Rate of Descent** - A higher rate of descent can be expected using M.84/329 KIAS versus ECON or LRC.
- Choose ECON or LRC if a slower descent is required for traffic, weather considerations or terrain clearance.
- **Fuel Consumption** - A higher rate of fuel consumption can be expected using M.84/329 KIAS versus ECON or LRC. The Critical fuel scenario is calculated using the M.84/329 KIAS diversion to the enroute alternate. However, if the Captain is concerned with alternate weather and anticipates an extended hold, the ECON or LRC profile could be selected.

- **Altitude** - The ECON single engine cruise altitude can be approximately 1,500 - 2,500 feet higher for the LRC profile. If there is a concern for weather, icing, traffic or terrain clearance the Captain may choose the ECON or LRC profile. CO SPD selection can result in approximately 4000 feet lower optimum altitude than LRC.

Following is an example based on a B777-224 IGW airframe:

ONE ENGINE INOP AT MAXIMUM CONTINUOUS THRUST

777-224 IGW/GE90-90B

CRUISE WEIGHT: 460,000 LBS.

	ECON D/D (237 KIAS)	310 KIAS	LRC @ MAX CRS	329 KIAS
Net Level Off Altitude ①	22385	16377	13543	14073
Gross Level Off Altitude ②	27302	21648	20812	19270
KTAS	350	423	367	432
Fuel Flow ③	9227 12321	9227 16028	9227 13019	9227 17462
Fuel Flow (%) ④	Base	+ 30.0%	+ 5.7%	+ 42.0%

Shaded area indicates Continental's "CO SPD" for one engine inoperative.

- ① Dispatch Calculations (Residual Rate of Climb is 1.1%)
- ② Actual Performance (Residual Rate of Climb is 0%)
- ③ Top figure is lbs/hr fuel flow at TOD M 0.84
Bottom figure is lbs/hr fuel flow at level off
- ④ % Difference. Derived at by, example: $16028 - 12321 \div 12321$ (%)

Note: Diversion at LRC Max Cruise Thrust would take about 30 minutes longer than .84/329 and may be considered for a non-time dependent diversion.

If one engine has failed or has been shutdown:

The PF should:

- Use HDG SEL to initiate a **turn of 90° away** from the track, normally away from the other tracks if on an outside track, or in the closest direct to the anticipated alternate if on a track bracketed on both sides. Use **25 degree on the bank angle** selector for max rate of turn.
- Set **FL 230 in the MCP** window. This will approximate the maximum E/O altitude for a typical weight.
- Select VNAV and on the CRZ page, **select ENG OUT, execute and confirm VNAV mode engaged**. This will automatically command max continuous thrust (CON). If the engine is still operating but at reduced power, CON will also automatically be selected upon execution of **ENG OUT CRZ**. (It also can be selected by pressing the CLB CON switch on the MCP, or by selecting CON on the THRUST LIM page.) Selecting **ENG OUT** will be reflected as **ACT EO D/D** on the CDU page. The aircraft begins a 300 fpm rate of descent while the airspeed bleeds off to the engine out speed. This is acceptable and is the preferred method as opposed to not executing engine out or not selecting a lower altitude on the MCP, which could result in the aircraft speed decaying to an unacceptable value if additional CDU/MCP inputs were not subsequently made.

WARNING: Do not allow the airspeed to decrease below the top of the amber minimum maneuvering airspeed band under any circumstances.

- Establish the **appropriate lateral offset** left or right (from ROUTE page or ALTN page) to the original track as required by the particular airspace rules and execute. Continue to use HEADING SELECT to turn and track the offset route until a new route to the alternate can be entered and verified. If continuing in the same direction as the original route, this new offset route could be tracked by LNAV. However, if the alternate lies in the opposite direction, the offset route cannot be tracked in LNAV and will not appear beyond the last waypoint of the original route.
- After clearing the lower limits of the track system, continue to descend and cruise at an engine out airspeed anywhere from minimum maneuvering speed to maximum certified operating speed based on the circumstances of the emergency.
- Use the ALTN page to divert to the desired alternate.

The PM should:

- Turn on all exterior lights.
- Advise on 121.5 of your approximate position, track, altitude, direction of deviation, and intended descent altitude. Example: *“Pan Pan Pan, this is COA 28 on track Charlie at 42W, FL 350, deviating north of track and descending to FL 230 due to an engine failure. Exterior lights are on, check your TCAS.”*
- When able advise the appropriate ATC facility of the situation, your requested altitude / routing, souls onboard, and fuel.
- Complete the ENG FAIL L, R checklist as directed by the PF.
- Advise the Company, cabin crew and passengers of your intentions.

Two Engine Operation

If it is necessary to begin immediate descent and also to proceed toward an alternate, the aircraft should descend at approximately 2,000 feet per minute at cruise Mach while acquiring a parallel track as specified above for one engine inoperative operation.

- When established on the specified parallel track, expedite descent to below FL 285. Upon descending below FL 285, proceed direct to alternate airport.
- Airspeed and point of descent is at Captain's discretion, depending upon the situation.
- Continue to broadcast position, altitude and intentions until ATC clearance is received. Inform ATC of altitude being maintained.

Diversion Procedure To The Enroute Alternate

Should a diversion become necessary, normally proceed to the appropriate designated **Suitable** ETOPS airport. However, in the rare event of a time critical catastrophic emergency where the aircraft must be landed immediately, the decision to proceed to an airport that is not reflected as the ETOPS alternate for the flight, rests with the judgement of the Captain (and Dispatch time permitting). It is vital that the weather, NOTAMS, and runway conditions be confirmed prior to committing to any airport.

Note: RTE 2 pages should be used continuously to monitor enroute alternates and Critical Points. The FIX pages may also be used as a quick reference for bearing and distance to an enroute alternate.

Note: In compliance with the enroute ETOPS portion of the ETOPS/LRN briefing card, the crew would have previously configured the ALTERNATE page to reflect the appropriate ETOPS alternates. The time / fuel estimates on this page of the FMC are predicated on current wind conditions (forecast winds are also included if the diversion route is within 99 NM of the programmed route). Also forecast winds to the alternate may be inserted to increase the accuracy of the calculations. If the flight can remain at altitude, the determination of which alternate is closest in point of time to the aircraft's present position can be determined more accurately by the FMC as opposed to the flight plan, which provides calculations at FL100 where the winds will normally be significantly different.

If a diversion is required select:

ALTN KeyPRESS

Enter or select the alternate airfield.

XXXX ALTN page is displayed.

LSK Opposite Alternate Airfield SelectedPRESS

Three route options to the airport may be selected:

DIRECT TO - direct to alternate

OFFSET – flight plan route with an offset

OVERHEAD – flight plan route to a waypoint then direct to alternate.

Select the desired option, and then:

DIVERT NOW Key (6R)PRESS

EXEC KeyPRESS

Check that the now modified route to the new destination changes to active route (solid magenta line) on the ND.

Note: Using the aforementioned procedures diverts the aircraft to the ALTERNATE AIRPORT – *not* – to a navigation facility. It is then necessary to correct the route and arrival as required to comply with subsequent ATC clearances, arrival, and approach considerations.

Note: ETOPS terrain clearance has been evaluated for M.84/329 KIAS, single engine diversion with Wing and Engine Anti-ice ON, maximum diversion gross weights and ISA + 15 temperature deviation. Terrain clearance if using a published “escape” route is assured under these conditions. Check MORAs and grid MORAs at this time.

Loss of Pressurization

Turn 90 degrees perpendicular to track and commence an Emergency Descent to FL140 / 14,000 feet or MEA, whichever is higher. Declare an emergency and divert if necessary. Be aware of high terrain on many ETOPS routes, including Greenland, Iceland, Canada, Alaska, and Russia. Selection of the TERR button will enhance situational awareness in high terrain areas.

WARNING: When flying the northern routes, colder than normal ISAs will cause the aircraft altimeters to read higher than actual altitude. Adjust altitude as necessary for terrain clearance (4% per 10 degrees below ISA). Refer to Cold Temperature Altitude Corrections in Section 3.

Visual depiction of the loss of pressurization escape routes can be readily accessed by Route 2 if so programmed. This will aid the crew in establishing a position on a charted airway or route with published MEA, MOCA, and terrain clearance procedures.

Uncontrollable Fire

A cabin or airframe fire, which becomes uncontrollable, may necessitate ditching the aircraft while control and consciousness can be retained. This should be considered as a last recourse. If required, descend at an appropriate rate / speed in preparation for the ditching. Notify all concerned as to your intentions, being sure to include the planned position of ditching.

Coast Guard Ditching Recommendations

In addition to the procedures listed in the Ditching section of the Flight Manual and ECL, the Captain should consider the following U.S. Coast Guard recommendations:

- Contact Oceanic Control as soon as possible via HF or SATCOM, and request that the Coast Guard be notified. Request an USCG Search and Rescue (SAR) aircraft. In addition, request the location of the nearest ocean vessel. (It will take the Coast Guard at least 15 minutes to plot ship locations.)
- Listen for contact with the SAR aircraft on 121.5 MHz, and squawk 7700 unless assigned another code. The SAR aircraft may intercept 1000' below your aircraft. Therefore, the altimeters of each aircraft must be compared prior to intercept to ensure safe vertical separation.
- If ditching is unavoidable, the Coast Guard may be able to recommend a ditching heading either through the SAR aircraft or from a surface ship. If possible, ditch in the lee of an island, in a lagoon, or near a ship.
- Coast Guard, Navy, and some merchant ships may have the capability of supplying homing signals, radar for intercept, flares for night ditching, and other aids. Standard Low Frequency homing signal is 410 Hz, giving the call sign, followed by 2 (two) 10 (ten) second dashes.

If a SAR aircraft is escorting you and you must jettison fuel, advise the aircraft to remain clear.

NAVIGATIONAL CONTINGENCIES

Most navigation errors occur when the equipment is functioning normally but the prescribed operating procedures are not followed. Compliance with established procedures in all geographic areas is essential to safe long-range navigation whether conducted overwater or over a landmass. It is every crewmember's responsibility to ensure that proper navigation procedures are followed at all times.

Note: The Jeppesen Enroute and Orientation charts contain important notes that pertain to loss of navigation, engine failure, etc. Pilots are encouraged to review these periodically.

Note: Most enroute FIR/ATC facility SATCOM frequencies are pre-programmed into the SATCOM and immediate voice communications can be established in a very short period of time to aid in the resolution of many non-normals.

Oceanic Entry With NAV Systems Inoperative

Loss of both FMC's (EICAS: **FMC**), inability to meet required navigation performance (EICAS: **NAV UNABLE RNP**), or loss of the inertial platform (EICAS: **NAV ADIRU INERTIAL**) prior to the oceanic entry point requires diverting to a **Suitable** airport where repairs or replacement of failed components may be accomplished.

To enter MNPS Airspace and fly Organized / Random Tracks requires a minimum of:

- 1 FMC connected to 2 CDUs, 1 with Alternate Navigation capability.
- ADIRU with no ADIRU Status Messages.

To enter MNPS Airspace via Special Routes requires a minimum of:

- 1 CDU with Alternate Navigation capability (LRN).
- 1 VOR/DME and ADF (SRN).
- ADIRU with no ADIRU Status Messages.

To continue within MNPS Airspace requires a minimum of:

- 1 CDU with Alternate Navigation capability.
- 1 VOR/DME and ADF (SRN).

Note: GPS is not required, but would be expected to be operational under most conditions and provides enhanced accuracy.

Note: In the unlikely event of an ADIRU failure the FMCs and ND Map will retain their functionality using GPS information for updating.

Unreliable Navigation / Error Detection

The procedures listed below are recommended if discrepancies are found between published and FMC Magnetic / True Courses, or Time and Distance display vs. Flight Plan data. Other abnormal indications such as an off-course postposition plot also indicate that an investigation is in order. When a malfunction or error occurs, the flight crew should guard against jumping to conclusions since hasty actions are seldom necessary and may further complicate the situation. Any time that navigational accuracy is in doubt, perform the following checks:

- Check Autopilot LNAV engaged and Flight Mode Annunciator match.
- Check correct coordinates in the ACTIVE Waypoint.
- Check Magnetic Course, True Course, distance displays, and wind on the FMC/ND. Compare to the values on the flight plan, map, and plotting chart.
- If in range of ground based navaid, compare FMC computed data with raw data (Coast Out / Coast In Check).
- Perform the FMC POSITION ACCURACY CHECK.

If unable to resolve a position disagreement problem, the following actions should be considered:

- Attempt to contact other nearby aircraft for wind, groundspeed, drift information, or other assistance desired. If a turnaround is advisable, use wind information from the POSITION REPORT to compute return headings.
- Use all means available to obtain as much navigational information as possible. (In some cases, it may be possible to establish and maintain visual contact with another aircraft on the same track.)

If confidence in position is still in doubt, contact ATC and declare unreliable navigation, broadcasting on assigned enroute frequencies and 121.5 mhz.

Gross Navigational Errors

Caution: A common cause of gross navigational errors is failure to re-engage LNAV after using the heading select mode to avoid adverse weather.

If a flight is observed by radar or otherwise determined to be 25NM or more off its cleared track (20NM in the Caribbean and the Pacific), ICAO rules require that ATC initiate a "Gross Navigation Error Report." ATC will advise the flight that a gross navigation error report is to be made. The pilot will be asked for his comments concerning the situation. ATC includes these comments in the report. The Captain and the FAA are required to respond to this report. The Captain shall:

- Personally retain all navigation documents (Master Flight Plan, Plotting Chart, ONL (if used), Clearance Messages, etc.).
- At the station of next landing, advise the Base Chief Pilot.
- Complete a written report on Form 21.9006, the Captain's Irregularity Report. All other flight deck crewmembers will prepare a written statement giving all pertinent details.
- Upon return to home base, personally deliver all the navigation documents and all written reports to the Base Chief Pilot.

Oceanic Navigational Error Reports (ONER)

ARTCC monitors the progress of all aircraft entering or exiting oceanic airspace. If an aircraft is observed 20NM or more from the centerline of the route on which it was cleared. ARTCC will notify the pilot of the observed position and distance off route and that an ONER will be filed. The contents and procedures of the ONER are similar to the Gross Navigational Error Report.

Reporting Navigation Equipment Malfunctions

Immediate reporting of a partial or complete loss of navigation capability to ATC is an ICAO requirement and compliance is required by FARs Part 91. If unable to continue flight in accordance with ATC clearance, follow the procedures listed on the appropriate enroute chart.

B777 DATA LINK COMMUNICATIONS GUIDE

ATC Data Link Services Summary

FIR/OCA/UAC LOGON ID	OCD	ADS	CPDLC	Remarks
ANCHORAGE PAZA	NO	NO	YES	<ul style="list-style-type: none"> Limited CPDLC service – may not be offered. VHF and HF voice and Radar primary, CPDLC secondary
GANDER CZQX	YES	YES	YES	<ul style="list-style-type: none"> Limited CPDLC services (only ALT requests, SPD Requests, and domestic frequency uplinks). CPDLC uplink clearances for ALT and SPD changes avail 2003 (check bulletins). A CPDLC logon required if entering from non CPDLC FIR. ADS transfer is automatic.
MAASTRICHT EDYY	N/A	NO	YES	<ul style="list-style-type: none"> Limited CPDLC service (Note: Inop Oct 02 - Feb 03). VHF voice and radar primary. CPDLC available for domestic European Upper Airspace Control (not Oceanic). Can LOGON on ground at FRA/EDDF, connection not indicated until passing FL150. VHF voice read back required only for CPDLC ALT, HDG, or SPD change clearances.
MAGADAN GDXB	NO	YES	YES	<ul style="list-style-type: none"> CPDLC LOGON ID (GDXB) different from FIR ID (UHMM). CPDLC position reports required.
NEW YORK KZNY	NO	NO	NO	<ul style="list-style-type: none"> ADS and CPDLC service expected late 2003 (check bulletins & NOTAMS)
OAKLAND KZAK	NO	NO	YES	<ul style="list-style-type: none"> ADS services expected 2003 (check bulletins & NOTAMS). Full CPDLC services, Oceanic position reports via CPDLC required. Services terminated approaching HNL, GUM, and western US domestic boundaries
REYKJAVIK BIRD	NO	YES	NO	<ul style="list-style-type: none"> On some routes VHF voice reports required in lieu of ADS.
SANTA MARIA LPPO	NO	YES	NO	<ul style="list-style-type: none"> Full ADS services.
SHANWICK EGGX	YES	YES	YES	<ul style="list-style-type: none"> Limited CPDLC services (only ALT requests, SPD Requests, and domestic frequency uplinks). CPDLC uplink clearances for ALTITUDE and SPEED changes avail 2003 (check bulletins). A CPDLC logon required if entering from non CPDLC FIR. ADS transfer is automatic.
SOUTH PAC	NO	YES	YES	<ul style="list-style-type: none"> Full CPDLC and ADS service. (Auckland, Brisbane, Melbourne, Nadi, Tahiti).
TOKYO RJTG	NO	YES	YES	<ul style="list-style-type: none"> Full CPDLC service. ADS expected Nov 02. (check bulletins & NOTAMS)

Oceanic Clearance Delivery (OCD) Procedures

GANDER Ocean Clearance Processor (OCP II)

1. Use the REQ OCEANIC CLEARANCE page from the COMPANY menu. (*All pilots must review data prior to selecting SEND.*)
2. SEND request (RCL) no earlier than 90 or later than 30 min prior to Oceanic entry point ETA.
3. Expect standard message response: IF NO CLEARANCE RECEIVED WITHIN 20 MINUTES OF OCEANIC ENTRY POINT REVERT TO VOICE PROCEDURES.
4. A “solicited” Oceanic Clearance is uplinked which contains a SEND prompt.
5. When clearance displayed, select SEND to accept. Select NEW MESSAGES to redisplay clearance, then PRINT for hard copy. There is no means to reject the clearance. *If clearance is unacceptable contact Gander OCD by voice.*
6. Contact Gander by voice within 200 NM of VHF frequency location as published on track message.
7. Initiate contact with **“Gander Delivery, Continental 10, read back”**. Read back only the ETA to the Oceanic entry point fix and clearance sequence number which immediately follows the header (i.e. OCEANIC CLEARANCE, 30150).
“Gander, Continental 10, estimating VIXEN at 0220, clearance sequence number 30150”
8. If unsolicited clearance uplinked (identified by no SEND prompt) when voice contact is made with Gander, read back the Oceanic entry point fix ETA, track letter, altitude, Mach, and TMI. If data link inop, contact Gander within 200 NM of VHF frequency location as published on track message and request clearance by normal voice procedures.
9. Unsolicited clearance uplinks to be replaced when Gander upgrades OCP II system in 2003; then voiceless like Shanwick.

SHANWICK Ocean Route Clearance Authorization (ORCA)

1. Use the REQ OCEANIC CLEARANCE page from the COMPANY menu. (All pilots must review data prior to selecting SEND.)
2. SEND request (RCL) no earlier than 90 or later than 30 min prior to Oceanic entry point ETA.
3. Expect standard message response: IF NO CLEARANCE RECEIVED WITHIN 15 MINUTES REVERT TO VOICE PROCEDURES.
4. When clearance displayed, select SEND to accept. Select NEW MESSAGES to redisplay clearance, then PRINT for hard copy. There is no means to reject the clearance. *If clearance unacceptable, contact by voice or consider sending a new RCL with the requested changes, which will start the entire process over again. If clearance is still unacceptable contact Shanwick by voice. If voice negotiation required, contact Shanwick using: “Shanwick, Continental 10, ORCA Contact”.*
5. If data link inop, contact Shanwick on 123.95 as per instructions on ATL Orientation chart, and request clearance using normal voice procedures.
6. ORCA system is totally voiceless for routine clearance requests. No unsolicited clearances. All clearances require a request (RCL).
7. If non-routine issues arise a CONTACT SHANWICK BY VOICE uplink will be received. Contact Shanwick ASAP on 123.95.

ADS and CPDLC Procedures For All FIRS

1. Logon 15 to 45 minutes prior to the FIR boundary.
 - Select COMM on the DSP, the ATC main menu, and open the LOGON/STATUS page.
 - Enter the four-letter logon ID (normally the FIR identifier).
 - Verify the flight number agrees with the ICAO flight plan and is in the following format – COA50.
2. For CPDLC services, the connection is verified on lower EICAS as ATC CONNECTION ESTABLISHED WITH XXXX.
3. For ADS services, the contract verification may be verified by selecting the MANAGER main menu, ADS page.
4. Following a CPDLC logon, send a CPDLC POSITION REPORT. (Not applicable North Atlantic)
5. CPDLC clearance procedures:
 - a. **Both PF and PM silently review clearance.**
 - b. **Both PF and PM discuss and agree on action: ACCEPT, REJECT, or STANDBY.**
 - c. **PF modifies FMC, MCP, comm frequency, transponder, and altimeter as appropriate, and requests PM verification.**
 - d. **If ACCEPT, the PM responds using either glare shield or MFD.**
 - e. **PF executes the clearance. (If altitude change, PF and PM point to and verbalize change on MCP.)**
6. Use of FREE TEXT should be avoided unless operationally necessary.
7. Be alert to “conditional” altitude clearances. e.g. “Maintain FL350. At (time) or (position) climb to and maintain FL370.” (A FIX page time reminder is recommended.)

Notes:

- 1) In areas where CPDLC and ADS services are both offered, the initial logon establishes the CPDLC connection and ADS contract.
- 2) In areas where only CPDLC or ADS services are provided, just the available service connects.
- 3) When transitioning from a FIR with ADS only, to a FIR with both CPDLC and ADS, an entry of the new FIR logon ID on the LOGON/STATUS page is required for the CPDLC connection. The previous ADS contract automatically transfers.
- 4) When transitioning to a FIR not offering ADS service, the existing ADS contract terminates at the first fix within the new FIR.
- 5) Problems have been experienced with the automatic transfer of the CPDLC connection from one FIR to the next. Approximately 15 to 30 minutes prior to the boundary the next FIR ID should indicate on the LOGON/STATUS page NEXT CENTER line. If the transfer does not occur, a manual LOGOFF and LOGON to the next FIR should be accomplished crossing the boundary fix.
- 6) In FIRs with only CPDLC service, position reports must be sent via CPDLC. In the northern and central Pacific, where airways contain numerous non-compulsory reporting points, the CPDLC POSITION REPORT page must be manually modified to reflect the correct position report. The format should be compulsory, compulsory, next. Next may be compulsory or non-compulsory.

ADS, CPDLC, and Polar Radio Procedures

1. When operating in areas where VHF voice communications are unavailable, an HF SELCAL watch must be maintained regardless of ADS/CPDLC services. Unless otherwise informed, the radio operator is expecting HF voice position reports. Therefore it is incumbent upon the flight crew to communicate their capability, intentions, and secure a SELCAL check.
2. Following are examples of proper radio phraseology:
 - Eastbound NAT flights:
To Gander Radio VHF, approaching the NAT: “**Gander Radio, Continental 50.**” After communications established: “**Continental 50, CPDLC, Shanwick next, request frequencies.**”
Expected reply: “Roger Continental 50 CPDLC, contact Gander on 5616 primary, 6681 secondary.”
To Gander Radio HF: “**Gander Radio, Continental 50.**” After communications established: “**Continental 50, CPDLC, Shanwick next, SELCAL AHBC.**”
Expected reply: “Roger Continental 50 CPDLC, at 30 West contact Shanwick on 5616 primary, 6681 secondary, standby for SELCAL.”
After SELCAL check: “**Gander Radio, Continental 50, good SELCAL check.**”
Expected reply: “Roger Continental 50, voice reports not required in the Gander OCA.”
Note: If Gander VHF or HF does not respond with “voice reports not required,” crew should prompt for clarification.
At 30 West: “**Shanwick, Continental 50.**” After communications established: “**Continental 50, CPDLC, track X-ray, SELCAL AHBC.**” (If on random route, last 2 waypoints in ADS airspace. Radio operator may ask for track exit points, even if on a track.)
 - Westbound NAT flights: Use similar radio procedures with Shanwick, Santa Maria, or Reykjavik.
 - Westbound Pacific, passing LAX enroute to HNL, logged on to CPDLC with Oakland Oceanic:
To ARINC VHF SFO radio: “**AIRINC, Continental 1.**” After communications established: “**Continental 1, CPDLC, request HF frequencies LAX westbound.**”
To ARINC HF SFO radio: “**AIRINC, Continental 1.**” After communications established: “**Continental 1, CPDLC, SELCAL CHPQ.**”
3. Polar Operations Area
 - Russian, Mongolian, and Chinese HF radio operators are for ATC purposes only and will not pass on position reports to the company. The use of Long Distance Operational Control (LDOC) service providers is necessary to relay company messages or initiate phone patch service (if available). See Polar Plotting chart for frequencies.
 - During times of solar disturbances, HF frequencies in the 2100 KHz range may provide the best results. ARINC (SFO Radio) operates a new family of HF frequencies with a transmitter at Barrow, Alaska (3013, 6640, 11342, 13348, 17925, 21964).

DATALINK COMMUNICATIONS

GENERAL

The use of ATC data link with participating air traffic control centers reduces the need for VHF or HF voice communications. Aircraft position reports, route changes, speed, vertical clearances, and voice contact requests can be requested or received.

Data link communication functions are initiated using either the CDU FMC COM function key for FMC uplinks including route, winds, performance, or takeoff data; or the COMM switch on the display select panel (DSP) for incoming or new Company and ATC messages.

Satellite Voice Communications

Satellite voice communications are available between the aircraft and the Company and between the aircraft and some Air Traffic Service (ATS) units. The SATCOM voice system is independent of the FMC and other aircraft data link systems. SATCOM voice is used when the priority to communicate requires discussion, conference calls, or time critical communications. This may include emergencies, Dispatcher – pilot operational discussions, or critical maintenance discussions where text communications are not appropriate.

COMPANY COMMUNICATIONS

Satellite Communications (SATCOM)

Primary company communications on LRN/ETOPS flights is via SATCOM data link or SATCOM voice. SATCOM is typically available south of 82°N prior to passing over or abeam the North Pole, and will be inoperative until approximately 80°N on the Russian side of the North Pole due to lack of satellite coverage.

The INMARSAT satellite constellation consists of four (4) geo-stationary equatorial communications satellites located over the Pacific, East and West Atlantic, and Indian Oceans. Air to ground calls are routed from the aircraft to the nearest satellite, then to a Ground Earth Station (GES). The GES is the gateway into the public telephone network where the call is routed as a normal ground-to-ground call.

Flight Following

Flight following by dispatch on Polar routes is a difficult task, complicated by the lack of satellite coverage in the vicinity of the North Pole, and the fact that Russia, China and Mongolia do not forward position reports.

To alleviate this problem push LSK 6R (REPORT) on the FMC POS REPORT page in the CDU approximately every two hours, and again when crossing 80°N on both sides of the North Pole. The position report data is sent via data link to the Dispatcher. If in the SATCOM inoperative area, the report is stored in the buffer and is sent automatically when SATCOM again becomes operational. Accomplish this procedure on all segments of Polar and NOPAC routing.

Long Distance Operational Control (LDOC)

If dispatch needs to contact the flight when operating outside of SATCOM voice or data range they will call the appropriate radio relay or ATC facility and advise them to relay a message to the flight, or request the flight contact dispatch through a phone patch with an LDOC provider if the facility does not have phone patch capability (i.e., Arctic radio). For this reason it is important that the crew obtain an updated SELCAL check prior to reaching a known SATCOM no-coverage area.

Available LDOC facilities include Arctic Radio, Cedar Rapids Radio, San Francisco Radio, Iceland Radio, Rainbow Radio, Houston Radio, Stockholm Radio, and Speedbird London. For HF frequencies, refer to the Communication boxes on the Jeppesen Polar Orientation Chart.

To establish LDOC communications with an ARINC station call on a general purpose (GP) frequency and request an LDOC frequency. LDOC frequencies are usually preceded by an asterisk (*) and are generally reserved for operational control issues. GP frequencies are generally reserved for ATC purposes.

On initial call to an LDOC station, advise them of the flight's approximate position. Once communications have been established, obtain the optimum frequencies and a SELCAL check. Generally, ARINC LDOC frequencies are not actively monitored unless a call is requested.

On Polar flights, depending on HF signal propagation characteristics, communications with an HF operator may be difficult above 80°N. However, other options are available. Arctic Radio (the GP operator that handles the ATC communications with Edmonton and Anchorage Centers) can also pass messages between the aircraft and dispatch, satisfying the company communication requirement.

During poor HF signal propagation an HF frequency in the 21,000 kHz range will usually work better. ARINC (SFO radio) maintains an LDOC family of five frequencies from 3000 to 21,000 kHz with the transmitter located at Barrow, Alaska.

ATC COMMUNICATIONS

General

The B777 is equipped with an FMC that is capable of fully interactive ATC data link operations. This is part of the FANS (Future Air Navigation Systems) avionics suite of the aircraft. FANS consists of two major applications, ADS and CPDLC.

Automatic Dependant Surveillance (ADS) is the aircraft position reporting function that requires no pilot action other than log on.

Controller to Pilot Data Link Communications (CPDLC) is the interactive ATC data link communications function.

The B777 is capable of three simultaneous CPDLC connections, four ADS (ATC) contracts, and one Company contract. This provides for future multiple entity flight following used in ATC boundary coordination and Company automated flight following.

FIR Data Link Status

Flight Information Regions (FIRs) bring FANS data link capability online in stages. Some FIRs are operational with both ADS and CPDLC functions, some have either ADS or CPDLC, and some are in the trial stages prior to going operational. Also, operational procedures may vary between FIRs.

Following is a brief summary, as of the date of this revision, of the operational status and procedures for applicable FIRs (logon ID):

- **Anchorage Oceanic (PAZA)**

VHF voice communications are primary and CPDLC is secondary. Radar is available in the greater part of Anchorage Oceanic except in the far western oceanic sector approaching the Tokyo boundary, and parts of the southern boundary with Oakland.

Anchorage may accommodate requests for CPDLC services, workload permitting, but uses voice in most cases.

Anchorage does not process ADS reports. ATC position reports are required over compulsory waypoints if not in VHF / radar coverage.

If using CPDLC within Anchorage Oceanic, be especially alert to the electronic CPDLC handoff to Tokyo Oceanic crossing the boundary at approximately 160°E at the named waypoints on the NOPAC routes.

SATCOM is available on an exception basis and not for routine communications.

If, after crossing the Anchorage / Tokyo FIR boundary westbound, no CPDLC logon is indicated to Tokyo (RTJG) within 5 minutes, perform a manual CPDLC logoff and initiate a new logon to Tokyo. This procedure would be applicable to any FIR boundary crossing where CPDLC services are offered in the receiving center.

- **Gander FIR (CZQX)**

Currently offers ADS services.

Limited CPDLC services begin in November 2002. A 3-stage trial is to be implemented. Stage I is the ability for a crew to request a flight level change. Stage II is the uplink of the domestic frequency. (Stages I and II occur simultaneously.) Stage III will occur in 2003 and include the ability to request / receive altitude and speed clearances. Requests for route offsets are not anticipated to be available in 2003.

- **Maastricht UAC (EDYY)**

The Netherlands has been conducting CPDLC trials for over two years with FANS aircraft. These trials are known as PETAL II, or Preliminary European Trials of Air Ground Data Link.

The PETAL II trials offer partial CPDLC services in parallel with VHF voice read back requirements. Maastricht UAC sectors operate in a VHF environment and have full radar coverage.

Participation in the PETAL II trials is fully voluntary.

If operating through the Maastricht UAC, review the following differences to ensure a successful operation:

1. Logon using EDYY 30 minutes prior to the Maastricht boundary (boundary not clearly defined on charts – look for COMM boxes). Eastbound flights logon over UK. Logon on the ground at FRA (connection inhibited until climbing through FL150). Do not expect a connect message right away. It may take until 10 minutes before the boundary for the connect message to be received.
2. Respond to uplinked messages via CPDLC; however, it is mandatory that **ALL data link clearances for altitude, heading, or airspeed changes MUST be confirmed via voice before the instructions are carried out.**
3. A limited number of down link request messages are available. Only one message at a time should be transmitted and under no circumstances should FREE TEXT be used, as the current Maastricht CPDLC system does not support the use of FREE TEXT in downlink messages.

4. No **UNABLE** or **REJECT** option exists in this system yet; accordingly, if any of the following three clearances are received and you cannot comply, a radio response of “UNABLE” is to be transmitted:
 - NO SPEED RESTRICTION
 - FLY HEADING (degrees)
 - TURN (direction) (degrees)
5. If a request with an unsupported system message is downlinked, an uplink notification of **SERVICE UNAVAILABLE** will be received and correlated to the appropriate message.
6. When receiving a message via CPDLC, respond via CPDLC then confirm via voice if the message is a clearance instruction. Do not leave a message open. Messages remain open for 2 minutes, then time out, and no further messages of the same type may be sent or received either by the aircraft or by the ground.
7. When in doubt, use voice to clarify.
8. Any problems encountered with PETAL II in Maastricht should be noted in a FREE TEXT - DATA LINK OP PROBLEM message downlinked to SOCC. The program managers at Continental will forward the issues to Eurocontrol for action. If the problem involves the aircraft, consider a logbook write up in addition to the data link report.

- **Magadan Center (GDXB)**

Offers full CPDLC services and can process ADS reports. Send an ATC Position Report via CPDLC passing compulsory waypoints until advised otherwise.

SATCOM communications are available through the Eurasia subdirectory of the SATCOM menu. Like most other CPDLC facilities, Magadan expects the use of SATCOM voice to be an exception to normal operations. Primary communications is via CPDLC.

Be alert for current and future routes that mandate CPDLC, ADS, and RVSM operations on certain segments (such as A218 west of Alaska to the western boundary of Magadan). Ball and box notes are used on enroute charts to advise of mandates.

No non-standard CPDLC procedures are employed in the Magadan Center airspace. Use of FREE TEXT should be avoided unless operationally necessary.

Until advised otherwise, ATC position reports via CPDLC are required over compulsory reporting points.

Be alert to crossing the Magadan boundary into non-CPDLC airspace. A **CPDLC SERVICE TERMINATED** ATC message and **ATC OFF DATALINK** EICAS message should be expected when leaving the Magadan Center airspace. If these messages are not received a manual CPDLC logoff should be accomplished.

- **Oakland Oceanic (KZAK)**

CPDLC communications are primary and HF voice through San Francisco Radio (AIRINC) is secondary. SATCOM voice is available on an exception basis and not intended for routine use.

Oakland does not process ADS reports. Although an ADS connection is indicated, Oakland cannot process ADS position reports in any of their sectors in the Pacific.

ADS services are expected to be implemented in 2003.

An ATC POSITION REPORT down link is required at each compulsory waypoint.

CPDLC electronic handoffs are available to all adjacent Oceanic facilities except U.S. Domestic and Honolulu airspace. Anchorage to Tokyo or Anchorage to Oakland may occasionally be a problem requiring manual logoff and logon to the receiving center.

- **Reykjavik (BIRD)**

Currently offers ADS services only.

- **Santa Maria FIR (LPPO)**

Currently offers ADS services only.

- **Shanwick FIR (EGGX)**

Currently offers ADS services only. Shanwick is expected to implement limited CPDLC service concurrent with Gander in late 2002.

- **Tokyo Oceanic (RJTG)**

Offers full CPDLC services and can effectively process ADS reports. However, Tokyo requires an ATC position report be transmitted via CPDLC passing any compulsory waypoint regardless of ADS capability.

When sending an ATC position report via datalink in a climb, the altitude passing when the report is sent is transmitted. The report is appended with a CLIMBING TO FLXXX suffix derived from the selected MCP altitude. In some cases ATC may still request a voice confirmation of assigned altitude.

SATCOM communication with Tokyo Oceanic is not currently available.

Tokyo Oceanic will accept a logon request on the ground at Narita (NRT). However, this is not a recommended procedure because a connection EICAS message with the chime will occur shortly after takeoff and could be distracting.

Oceanic Clearance Delivery (OCD)

Oceanic Clearance Delivery (OCD) is a datalink feature that is entirely separate from the FANS ADS/CPDLC functions. OCD provides a means for the flight crew to request the oceanic clearance via ACARS. It is found under the COMPANY main menu not the ATC main menu.

In the North Atlantic, Gander and Shanwick are equipped with automated ocean clearance request and delivery systems. In Gander, OCP II (ocean clearance processor), and in Shanwick, ORCA (ocean route clearance authorization), are designed to reduce reliance on voice communications and permit the request and delivery of oceanic clearances. These systems are evolutionary in nature and updated as technology and financial constraints allow. As of this printing, Shanwick's ORCA system is more mature than Gander's OCP II. Refer to OCD Procedures in this section for detailed information on using these systems.

Automatic Dependant Surveillance (ADS)

Automatic Dependent Surveillance is a data link feature of FANS that permits certain Air Traffic Service (ATS) units to monitor a flight. Such a connection is commonly referred to as an ADS "contract." ADS may be required on routes referred to as CNS or FANS. ADS is available by default. It remains available (armed) unless selected off by the crew. When ADS is armed, automatic position report messages are sent to ATC and, when in the North Atlantic, the Company. ADS operation is completely transparent to the crew. ADS is independent of CPDLC and normally does not require the crew to log on. Thus, ADS can be active even when the flight is not logged on. Logon is required in the North Atlantic.

Control of the system and its status is accessed on the ADS page from the MANAGER main menu. ADS ARM enables ADS function, ADS OFF inhibits ADS function, and ADS EMERGENCY provides more frequent position reports.

ADS reports may include the following when enabled in the ground system:

- Flight number
- Preset position, time and altitude
- Next position and ETA
- Subsequent position

- Wind velocity and temperature (Met reporting)
- Magnetic heading and indicate airspeed
- True track and groundspeed
- A number ranking FMC navigation quality
- TCAS operability.

The airborne system is capable of responding to an ATS unit request for ADS reports with no alerting to the flight crew (unless the crew selects ADS OFF), as follows:

- At the passage of each waypoint (except abeam points) on the FMC active route (event contract).
- At intervals established by ground systems (periodic contract).
- After a deviation of more than a specified number of feet from the assigned altitude
- After *any* lateral deviation from the assigned track
- If the FMC ANP exceeds the RNP specified for the area.

Controller To Pilot Data Link (CPDLC)

General

ATC data link is available with participating air traffic control centers, reducing the need for VHF/HF voice communications. Aircraft position reports, route changes, speed, vertical clearances, and voice contact requests can be downlinked or uplinked as appropriate. The **COMM** display ATC main menu selection allows display of downlink message pages.

Uplink and downlink messages are stored. All messages are assigned the time of receipt / transmission and are printable. Message status is also displayed for ATC messages.

ATC data link requires manual logon to a participating ATC facility. Once logged on, transfer to adjacent and equipped ATC facilities is normally automatic.

Crew Feedback

ATC uplinks containing clearance data that the crew can set on the MCP or EFIS control panel have a crew feedback display function. When the message is displayed on EICAS or the message page, the data values change from white to green when properly set by the crew. Data that provides feedback is:

- MCP speed
- MCP heading
- MCP altitude
- Altimeter setting
- Transponder code
- VHF frequency
- HF frequency

FMC Data Loading

Some ATC uplinks may contain route data for loading into the FMC. Display of the **LOAD FMC** command key indicates that FMC data is available for loading. Selecting **LOAD FMC** transfers data to the FMC and creates an FMC modification. This allows the crew to evaluate the proposed change before executing the modification. As always, the modification is erasable prior to execution.

Both MFD information messages and FMC scratchpad messages provide indications of loading progress.

Uplinked ATC Messages

Arriving ATC uplink messages are annunciated by an **•ATC** communications message, a HI-LO chime, and the display of the EICAS ATC message block. The message text is displayed below the normal EICAS engine display. Uplink messages too large to fit in the message area display the message **LARGE ATC MESSAGE**. The message text is displayed using the **NEW MESSAGE** menu selection.

ATC messages requiring an accept or reject response display option keys at the bottom of the EICAS display. Responses are made via the MFD message page or via the **ACCEPT**, **CANCEL**, and **REJECT** switches on the glareshield.



GLARESHIELD PANEL

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Note: The **ACPT** switch contains a raised circular face, which allows it to be easily distinguishable from the **CANC** and **RJCT** switches by touch.

The upper EICAS ATC message block and glareshield ATC response switches allow crews to respond to ATC uplinked messages without going heads down into the MFD.

When viewing the CPDLC message on the MFD using the COMM button on the DSP, the status of the message is displayed on the upper right corner. The status of an ATC message uplink can be OPEN, ACCEPTED, REJECTED or STANDBY, as responded to by the crew. The status of a pilot downlink request can be OPEN, AFFIRMATIVE, NEGATIVE, UNABLE or STANDBY, as responded to by the controller.

Refer to ATC PAGES of this section for additional information on messages and command key locations and functions.

OPERATING PROCEDURES

General

This section provides standard operating procedures for flights operating in FANS airspace. As of the date of this revision mixed implementation of FANS applications exist on the B777 route structure.

ADS is operational in most of the North Atlantic airspace, while CPDLC trials are underway in selected FIRs.

CPDLC is operational in the Pacific but not ADS.

Preflight

When using either the LOGON/STATUS page or RTE page 1 LSK 2R, the flight number must be entered exactly as it appears on the ICAO Flight Plan. This will always require changing the uplinked flight number (or entering manually, if no uplink received) on RTE page 1 as follows:

- Enter COA followed by the flight number
Note: For military charters using the “REACH” call sign, enter RCH followed by the flight number.
- Do not use any leading zeros unless indicated on the ICAO Flight Plan.

Example: If the RTE 1 uplink was 004, it must be changed to COA4.

The flight number entered on RTE page 1 automatically propagates to the ATC LOGON/STATUS page.

OCD Procedures

The following acronyms apply to Oceanic Clearance Delivery procedures:

RCL = Request Clearance, CLA = Clearance, OCD = Oceanic Clearance Delivery.

The oceanic clearance may be requested via datalink. Send the request not earlier than 90 minutes before, and not later than 30 minutes before the ocean entry point ETA. If departing an airport less than 30 minutes flying time to the ocean entry point, do not use this data link request but make the request via voice procedures on the appropriate frequency. (Refer to the North Atlantic Orientation chart for OCD voice frequency). Accomplish the following specific steps in order:

1. Press the DSP COMM button and select the COMPANY main menu and REQ OCEANIC CLEARANCE page. The displayed page is titled NORTH ATLANTIC OCEANIC CLEARANCE REQUEST.
2. Select the **SHANWICK** or **GANDER** prompt and complete the following fields as required:

ICAO FLT NBR: COA Enter filed flight number with *no leading zeros* (unless the ICAO flight plan contains zeros), i.e., COA50. Military charters using the “REACH” call sign enter RCH

ENTRY POINT: Enter the appropriate filed Shanwick Oceanic boundary entry point name. Most boundary points are named waypoints. If LAT/LONG is required use the format N55W010 or 55N010W. Do not use the "coded" format (5115N) *as this will result in the request being rejected.*

ENTRY PT ETA: Enter the ETA for the Entry Point.

FLIGHT LEVEL: Enter the requested Flight Level.

MACH: Enter the requested Mach number using the decimal *even though the decimal already appears.*

REMARKS:

MAX FLIGHT LEVEL: Enter the maximum acceptable Flight Level at the entry point by reference to FMC altitude capabilities.

ALT TRACK:

Enter the OPTIONAL TRACK shown on the CAL Flight Plan or the second choice of track if not shown.

OTHER:

Enter any remarks for the OCD controller.

3. All pilots on the flight deck must review the above information for accuracy **before it is sent**.

Notes:

Data entry errors on the Oceanic Clearance Request Screen will likely result in a **REVERT TO VOICE** message response, or an undesired altitude or Mach assignment.

As always it is paramount that if the down-linked ETA for the oceanic entry point changes by **3 minutes or more**, the flight must advise the current ATC controlling agency and confirm coordination with the oceanic control agency. This may be accomplished by sending a new REQUEST (RCL) with the updated ETA and a note in REMARKS indicating “Revised ETA over...”.

4. After all pilots have reviewed the data, **SEND** the REQUEST (RCL).
5. After a brief delay, normally less than 1 minute, the following message will be received:

**COA (flight number) RCL RECEIVED IF NO CLEARANCE WITHIN
15 MINUTES REVERT TO VOICE PROCEDURES**

END OF MESSAGE

6. Within a few minutes the oceanic clearance will be received via datalink as in the following example:

PRESS SEND TO ACCEPT

30AUG01 12:07 OCEANIC CLEARANCE N78002

1206 010830 EGGX CLRNCE 048
COA11 CLRDR TO KIAH VIA 51N015W
NAT FOXTROT 51/15 51/20 51/30 51/40 50/50 YQX
FM 51N015W 1254 MNTN F350 M084
END OF MESSAGE

All pilots on the flight deck must review the datalink oceanic clearance for accuracy. Following is an explanation of the message:

PRESSSENDTOACCEPT	will down link the receipt of the message and acceptance of the clearance When SEND is selected an electronic copy of the uplinked clearance is downlinked to the ground and electronically compared to the stored clearance. If any differences are detected a revert to voice uplink message will be received.
30AUG01	date message received by aircraft
12:07	time (Z) message received by aircraft
OCEANIC CLEARANCE	title of message
N78002	aircraft registration number message sent to
1206	time (Z) message was sent
010830	date message was sent in yr/mo/dy
EGGX CLRNCE	facility sending the message
048	number of specific CLRNCE
COA11	flight that message is addressed to
CLRDR TO KIAH	flight plan destination cleared to
VIA 51N015W	oceanic entry point cleared to
NAT FOXTROT 51/15 51/20	North Atlantic Track "F" & route lat/longs
51/30 51/40 50/50 YQX	(should agree with the published daily track message)
FM 51N015W 1254	from over entry point at ETA
MNTN F350 M084	maintain FL 350 and Mach .84 on the track-- <i>this is not a clearance to climb/descent to this altitude or to change mach now-as always, that needs to be coordinated with the domestic ATC facility</i>
END OF MESSAGE	indicates last part of message to insure no data or lines lost. Included in all OCD uplinks

Caution: There have been isolated cases of Continental aircraft receiving uplink messages that were intended for other Continental flights. **It is paramount to ensure the clearance received is valid for your particular flight and aircraft registration number by reviewing all the above data.** This is one very good reason to insure that the ATC and ICAO flight plans reflect both the correct flight number and aircraft registration number, especially after an aircraft substitution! If there are any doubts, contact the OCD facility via radio and resolve the issue.

VERY IMPORTANT: There is no means to **REJECT** a Data Linked Oceanic Clearance since the ground system is unable to process a **REJECT**. If you wish to reject a clearance, the current clearance must be accepted, (**SEND**) and a new request sent. For instance, if the clearance contains an altitude or Mach that is unacceptable, or a track that cannot be flown due to specific ETOPS AOA constraints, then a new RCL should be sent with appropriate comments outlining the issue. If the situation is time critical (approaching the entry point or clearance limit) revert to voice procedures. Only one request may be outstanding at a time.

All pilots on the flight deck must agree to SEND and accept the clearance, or to SEND and request a new clearance via datalink or if required, by voice.

7. Select the **SEND** prompt. Re-select **NEW MESSAGES** to again display the clearance and then select **PRINT** for a hard copy. *If **PRINT** is selected first, the **SEND** prompt will be blocked, and the message will have to be re-displayed in order get the **SEND** prompt back on screen.*
8. **All pilots on the flight deck must then cross check the hard copy datalink oceanic clearance with both the daily track message and the current FMS waypoints for accuracy.**

If there is a track change from the track currently loaded in the FMS, the following procedures should be used:

- The PF will load the new track waypoints into the active route (normally RTE 1) of the FMS.

- Then the PF will give the hard copy of the data-linked Oceanic Clearance to the PM. The PF will then read the new FMS waypoints aloud to the PM who will verify the waypoints on the hard copy of the uplinked oceanic clearance by circling each waypoint in the manner as is accomplished during the pre-departure route verification process.
 - After verification of the new track, the PF will then **EXEC** the change. If necessary, leave a discontinuity between the currently cleared **domestic routing** and the **new track entry point** until such routing is coordinated and cleared by ATC.
 - If a hard copy of the CAL flight plan for the new track is available, course and distance should be checked at each waypoint just as it would with the original flight plan. If not available, consider writing the new track waypoints above the original track waypoints and circling and “X-ing” in the standard method. This will afford a method to keep track of time and fuel. It will also provide some idea of magnetic heading to fly in the event of having to revert to the magnetic compass providing the new track is parallel to the original CAL flight plan track, and does not penetrate AMU airspace.
 - If the new track turns out to be the same as the **OPTIONAL TRACK** on the CAL Flight Plan, then it should reflect the appropriate coast in routing (common/non-common/NAR) for the new track. In all cases, confirm the domestic routing with ATC during coast in after any track change.
 - As always, track changes should be coordinated with SOCC.
9. Shortly thereafter, an uplinked **FLIGHT SERVICE MESSAGE** will be received acknowledging the flight’s acceptance of the clearance as in the following example:

30AUG01 12:08 FLIGHT SERVICE MESSAGE N78002

1208 010830 EGGX
COA11 CLA RECEIVED
CLEARANCE CONFIRMED

END OF MESSAGE

Additional Notes

- Any errors noted by the ground system will uplink a **REVERT TO VOICE** message to the flight.
- A subsequent clearance may be annotated RECLEARANCE 1, RECLEARANCE 2, etc. **Be alert for revised entry point time restrictions that may accompany reclearances.**
- Any uplinked message from Shanwick Oceanic Clearance Delivery will always end with END OF MESSAGE.
- If you send a second or subsequent RCL (Request Clearance) before an uplinked message is received, the following message will be received:

COA (flight number) RCL REJECTED CLEARANCE ALREADY BEING PROCESSED AWAIT TRANSACTION COMPLETION END OF MESSAGE

- There is no connection between the datalink Oceanic Clearance Delivery (OCD) procedure, and any ADS or CPDLC procedure. If you need to communicate via voice with the Oceanic Clearance Delivery Controller, DO NOT USE THE TERM ADS. Also, do not refer to ADS or CPDLC in the REMARKS section of the OCEANIC CLEARANCE REQUEST.

The majority of Gross Navigation Errors occur during oceanic track changes. The use of Electronic Oceanic Clearance Delivery provides an additional margin of safety by providing the crew with a hard copy of the oceanic clearance, greatly assisting in the programming of the new track data.

ADS Procedures

Logon

The following logon procedures may be partially accomplished on the ground during preflight (up to selecting the **SEND** prompt), or in flight between 15 and 45 minutes prior to crossing the first ADS Oceanic FIR boundary.

1. Select the COMPANY main menu followed by ATC then the LOGON/STATUS page.
2. On the LOGON/STATUS page in the LOGON TO space enter the appropriate identifier for the FIR. (CZQX for Gander, EGGX for Shanwick, etc.) These FIR identifiers are found on the charts at the FIR boundaries.
3. Ensure the TAIL NUMBER space contains the full registration number as indicated on the SELCAL placard, and CO is in the AIRLINE space.

4. 15 to 45 minutes prior to the FIR boundary select the **SEND** prompt and observe **SENDING** then **SENT**. (**SENT** is an ARINC acknowledgement of receipt of the logon request).
5. Select the **MANAGER** main menu, then the **ADS** page and observe:

TIME xxxxZ – ADS CONNECTION ESTABLISHED WITH DDLCAXA

This is the verification that an ADS contract has been established with the ARINC Central ADS System (CADS). ARINC sends the position reports received from ADS flights to the appropriate FIR/OCA via a dedicated, high-speed landline. When crossing an FIR boundary into another FIR offering ADS services, the transfer logon is handled automatically within the ARINC CADS system. When these transfer logons take place, the LOGON TO address on the LOGON/STATUS page will not change from the address originally entered.

Radio Procedures

Prior to entering ADS airspace, the flight will be instructed to contact the appropriate RADIO service.

1. Use the term “ADS” after the flight’s call sign, request frequencies, and state name of next FIR.

Example: [Gander Radio VHF] “GANDER RADIO, CONTINENTAL 34 ADS, REQUEST FREQUENCIES, SHANWICK NEXT.”

The VHF Operator will provide the initial 2 HF frequencies, and the HF Operator should provide the two frequencies for the next FIR if they are different.

Note: If the VHF Operator includes the response that position reports are not required, it is not necessary to again receive the same response from the HF operator.

2. Prior to entering the FIR, request a SELCAL check on HF.

Example: [Gander Radio HF] “GANDER RADIO, CONTINENTAL 34 ADS, SHANWICK NEXT, SELCAL ERHG.”

3. At the completion of the SELCAL check, the Radio Operator should respond that position reports are not required (unless previously advised by the VHF Operator), and issue frequencies for the next FIR.

Example: “CONTINENTAL 34 ADS, VOICE REPORTS NOT REQUIRED IN GANDER FIR. AT 30°W CONTACT SHANWICK RADIO ON PRIMARY 8864, SECONDARY 5531.”

Note: When the SELCAL check is complete no further use of the term ADS is necessary until the next FIR boundary SELCAL check.

4. Passing 30°W, contact the next FIR on the previously assigned HF frequency, and using the term ADS after the call sign, report the track letter and request SELCAL check.

Example: “SHANWICK, CONTINENTAL 34 ADS, TRACK X-RAY, SELCAL ERHG.”

Note: If assigned a Random Route rather than a track, report the last two fixes on the cleared Oceanic route of flight.

Example: “GANDER, CONTINENTAL 34 ADS, SCROD, VALIE, SELCAL ERHG.”

5. After this SELCAL check, the Radio Operator will provide a VHF frequency contact instruction for a specific exit point, (usually 015°W or 010°W eastbound, or approaching 050°W westbound).

Example: “CONTINENTAL 34 ADS, VOICE REPORTS NOT REQUIRED IN SHANWICK FIR. AT 15°W CONTACT SHANNON CONTROL ON VHF FREQUENCY 131.15.”

Note: Always default to providing HF voice position reports unless otherwise instructed. Occasionally, Radio Operators will forget to advise the crew to omit voice reports. If this happens, simply ask the operator to “assure voice reports not required.”

SOCC Flight Following

Dispatchers are required to monitor each flight's progress. They are copied with ADS position reports; however, ADS reports do not contain a fuel remaining value. Therefore, at 20°W and 40°W, in both flight directions, use the CDU and send an FMC position report. (FMC POS REPORT page, LSK 6R labeled REPORT>.)

Operational Notes

- Always monitor the time for the NEXT position as reported (and logged on the Master Flight Plan under the RETA column), and transmit an update if this time is found to be in error by 3 minutes or more. One technique is to enter the reported ETA to the next waypoint on the FIX page so that it overlays the current displayed ETA when DATA is selected on the EFIS control panel. Any changes would become apparent by divergence of the two displayed times.
- If a failure prevents ADS waypoint reporting, HF voice position reports are required and will resume as soon as possible. If the failure occurs prior to initial contact with RADIO, do not use the term “ADS,” and proceed with normal HF voice reporting procedures.
- If problems are encountered with the system such as UNABLE TO LOGON or ALL ADS CONNECTIONS LOST indicated on the ADS page: check the SATCOM status or if prior to coast out and still within VHF coverage, check center VHF radio in DATA. If still unable to continue with ADS, initiate or resume HF voice position reports and send a DATA LINK OP PROBLEM report from the COMPANY main menu FREE TEXT MESSAGE page. This is necessary so that a Continental data link analyst or Flight Technical Pilot can review the problem and determine whether the problem was related to an aircraft system or the ground ADS network.
- If advised, or crew becomes aware they have provided an incorrect ATC LOGON Flight ID, they shall terminate ADS by selecting the ADS page from the MANAGER main menu, select ADS OFF, then ADS ON, then re-logon with the correct Flight ID. Both pilots will confirm the correct Flight ID on the ATC main menu LOGON/STATUS page. This may also be an effective technique in case of problems with the downlink of the ADS reports. Resetting the system has worked in cases where SATCOM was operational but the ADS reports stopped transmitting.
- **Do not insert any non-ATC waypoints in the active route. This will generate inappropriate position reports and increase the controller’s workload.**
- ADS operations are exempt from all routine (wind and temperature) MET report requirements.
- ADS reports transmit the aircraft’s actual position.

Caution: If an OFFSET is executed for wake turbulence or weather, the start and termination of the offset must be reported via voice. (The Oceanic Controller must reconcile any differences between a position report and the cleared route.)

- Leaving ADS airspace resume voice communications as instructed. The ADS contract will be automatically terminated upon crossing the first waypoint outside of ADS airspace.
- If there is an emergency, ATC expects voice procedures to be established at the crew's earliest opportunity. On the ADS page, ADS EMERGENCY ON may be selected. This causes an emergency position report to be transmitted when selected, and each 30 minutes thereafter, until ADS EMERGENCY OFF is selected or ADS connections are lost. ***Exercise caution when viewing or changing this selection.***

Note: An Emergency ADS report in today's security conscious environment that is not reconciled in a reasonable time via voice may cause in-flight intercept procedures to be implemented, or anti-terrorist planning actions on the ground. Communicate with ATC as soon as possible via any means available if your flight deviates off the cleared route or you have selected ADS EMERGENCY ON. The following is an extract from a bulletin published recently by Boeing:

...When an ADS Emergency indication is noted by ATC, and no follow-up emergency measures (communication of divergence from track and/or altitude) are observed from the aircraft, ATC will contact the aircraft to confirm that selection of ADS emergency function was intended. This communication will be via controller-pilot data link communication (CPDLC), where available, and by voice in other areas. The message will be a routine request with "CONFIRM ADS" appended in free text.

If the emergency function was activated purposely, the crew should acknowledge the uplink message by explaining the flight's status. If, for any reason, clarification of aircraft status is not possible, the crew should respond to the data request and leave ADS emergency function selected to ON or should not respond at all. If the crew finds that the function has been inadvertently activated, the function should be selected to OFF and the response to ATC should be "ADS Reset" either by CPDLC or voice.

The current emphasis on security is likely to result in unexpected consequences if ADS is left in emergency and a reasonable, timely explanation is not provided by the crew. Recently an aircraft was met by anti-terrorist forces after the crew inadvertently selected the ADS emergency function to ON, failed to respond to the ATC inquiry in the standard way, and subsequently landed with the emergency function still selected to ON. It should be noted that US armed forces may be authorized to intercept aircraft suspected of being under the control of unauthorized personnel.

- When logged on in the North Atlantic, 2 ADS contracts are established with the aircraft: an EVENT contract, for reporting FMC waypoints; and a PERIODIC contract, set at 30 minute intervals for reporting position, wind, and temperature.
- Radio Operators may use terms such as Oceanic Control Area (OCA), Area Control Center (ACC), or Flight Information Region (FIR), in describing the next Air Traffic Service Provider

CPDLC Procedures

Logon

Logon procedures for CPDLC are identical to the ADS logon procedures. (If operating in an FIR with both CPDLC and ADS capabilities, only one logon would be required.)

When CPDLC connection is established:

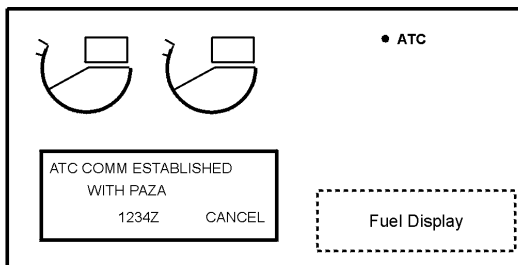
- Four letter identifier displays at ACTIVE CENTER line on LOGON/STATUS page.
- ESTABLISHED displays at the ATC CONNECTION line.
- Communication message **ATC COMM ESTABLISHED WITH XXXX** appears in ATC uplink message block of EICAS display.
- Hi/Lo chime sounds.
- Next center is displayed only when controller initiates handoff procedures.

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z LOGON / STATUS		
ACTIVE CENTER: KZAK		
NEXT CENTER: PAZA		
ATC CONNECTION: ESTABLISHED		
LOGON TO: KZAK		
FLIGHT NUMBER: COA7		
TAIL NUMBER: N78005 AIRLINE: CO		
RESET RETURN EXIT		

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**LOGON / STATUS PAGE
FOLLOWING SUCCESSFUL LOGON**

Note: Subsequent ATC connections are automatic. NEXT CENTER station identifier transfers to ACTIVE CENTER window on the ATC main menu LOGON/STATUS page, accompanied by an ATC uplink message block message and chime.



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Position Report Send

Select POSITION REPORT page from ATC main menu and select SEND. Per controller protocol, no further communication from ATC occurs until the flight crew has sent a position report. This also applies to transiting an FIR boundary from one data authority (CPDLC FIR) to another. Note the term DATA AUTHORITY is used to denote the controlling ATC facility.

CPDLC Airspace

15 - 45 minutes prior to entering CPDLC airspace:

Appropriate Radio Communications Operator Contact

Crews must contact the appropriate radio facility to obtain the VHF or HF frequency or frequencies required for backup communications in the next FIR/OCA. On initial contact with this facility, identify the flight by using the call sign "CONTINENTAL XXXX CPDLC." This alerts the radio operator that subsequent reports will be via datalink. Obtain a normal SELCAL check. A SELCAL / radio watch must be maintained.

Note: SATCOM voice is not considered an acceptable backup to datalink communications during CPDLC operations. If CPDLC fails, revert to VHF if available, HF, then SATCOM.

Note: SATCOM calls are most often routed to a supervisor or flight data position. Communication directly with a controller may take some time.

Prior to each flight segment in CPDLC airspace:

Correct RNP Value (on POS REF page 2/3).....VERIFY

Responding To ATC Uplink Clearances

The following procedure is mandatory. It serves as an error management tool and works to ensure misunderstandings are avoided in the evaluation and execution of an ATC clearance.

When an ATC uplink clearance message is received:

PM: COMM Display SwitchSELECT

New datalink clearance message displays automatically.

PF, PM: Uplink Clearance..... SILENTLY REVIEW CLEARANCE

PF, PM: Uplink Clearance..... REVIEW, DISCUSS, EVALUATE

Discuss and agree on the action to take: **ACCEPT, REJECT, STANDBY**.

Utilize **STANDBY** key if additional time is needed to evaluate the uplink.

PF: MCP/FMCSET / LOAD (DO NOT EXECUTE)

New setting must not be executed until the uplink has been accepted.

PF, PM: MCP/FMC Entries.....VERIFY

Using crew feedback feature, observe correctly entered value changes from white to green within ATC uplink message block. For altitude changes, both pilots also verbalize and point to the MCP window value.

Note: Uplink message clearance value turns green when correctly entered even for conditional clearances (e.g., AT 140W CLIMB AND MAINTAIN FL350).

If Clearance is a route change:

PF: LOAD FMC Key.....SELECT

To view the **LOAD FMC** prompt, the uplinked message must be opened on the MFD.

Loads data directly into the FMC and creates a MOD in the active route.

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
2353Z ATC UPLINK		
DIRECT	N56E166	
DIRECT	N47E159	
DIRECT	N46E153	
DIRECT	N43E147	
DIRECT	N38E143	
DIRECT	SNAIL	
ACCEPT	LOAD FMC	PRINT
STANDBY	REJECT REASONS	REJECT

777TB0001N

PF, PM: Uplinked Data REVIEW, DISCUSS, EVALUATE

Evaluate the uplinked route change by observing the modified route on the map display. Do not execute until decision to accept is made (ensure execute light remains on during evaluation).

If decision is to accept uplink:

PM: ACCEPT Key / ACPT Switch.....SELECT

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1228Z CLIMB AND MAINTAIN FL350 ATC		
ACCEPT	PRINT	REJECT REASONS
		REJECT

777TB0001S

PF: MCP/FMC Entries EXECUTE, IF APPLICABLE

Execute the change using established procedures.

If decision is to reject uplink:

PM: REJECT REASONS Key.....SELECT

Select preset reason for rejecting clearance if possible. Use free text box only if preset reasons are inadequate.

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1228Z CLIMB AND MAINTAIN FL350 ATC		
ACCEPT	PRINT	REJECT REASONS
REJECT		

777TB0001T

Note: Selecting DUE TO WEATHER increases the priority of the message at the controller’s workstation.

Note: Free text messages cannot be loaded into the FMC and do not have crew feedback capability. Pre-formatted messages are preferable in order to limit usage of unfamiliar abbreviations and/or phrases.

PM: REJECT Key / RJCT SwitchSELECT

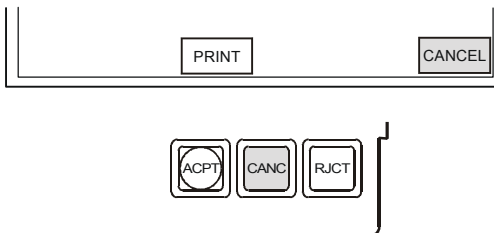
Sends (downlinks) rejection reason to ATC.

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z REJECT REASONS		
<input type="checkbox"/> DUE TO AIRCRAFT PERFORMANCE		
<input checked="" type="checkbox"/> DUE TO WEATHER		
<input type="checkbox"/> NOT CONSISTENT, PLEASE RE-SEND		
FREE TEXT: ----- ----- -----		
RESET	RETURN	REJECT

777TB0001Q

PM: CANCEL Key / CANC Switch.....SELECT

Clears ATC message on MFD and ATC memo message on the upper EICAS (if no other pending messages in queue).



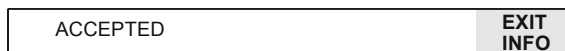
777TB0001R

Automatic (Armed) Reporting To ATC

Use armed reports to automatically send reports to ATC whenever a requested report has been received, e.g., REPORT REACHING FL350.

After the original datalink clearance has been accepted and executed:

PM: EXIT INFO Key.....SELECT



777TB0001M

PM: DISPLAY REPORT Key.....SELECT

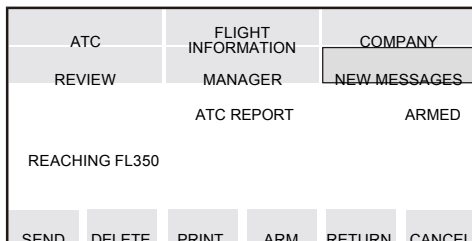
The pending downlink request portion of the ATC message is displayed.



777TB0001O

PM: ARM Key.....SELECT

Once the ATC request has been achieved, a report is automatically sent to ATC and the crew receives a confirming message.



- Note: The **ARM** key may also be accessed via the ATC REQUESTED REPORTS page under the ATC main menu. The page is normally inhibited until an ATC REQUESTED REPORT is uplinked, thereby removing the inhibit.
- Note: Selecting the **SEND** key instead of the **ARM** key sends the report immediately rather than following achievement of the request.

Pilot Initiated Requests

Use ATC main menu to make applicable requests to ATC (**CLEARANCE REQUEST** key is not currently used in FANS operations). Use the second page of the ALTITUDE and ROUTE REQUEST selections to explain the reason for those requests. As for the REJECT REASONS page, selecting DUE TO WEATHER increases the priority of the message at the controller’s workstation.

To query ATC on the status of a downlinked request (after a reasonable amount of time), use the WHEN CAN WE EXPECT key rather than re-sending the same request. The system cannot accept two open requests from the same REQUEST key page.

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
ATC		
ALTITUDE REQUEST	WHEN CAN WE EXPECT	EMERGENCY REPORT
ROUTE REQUEST	VOICE CONTACT REQUEST	ATC REQUESTED REPORTS...
SPEED REQUEST	LOGON / STATUS	POSITION REPORT
CLEARANCE REQUEST		FREE TEXT MESSAGE

77710014

Descent

Prior to each flight segment in FANS airspace:

Correct RNP Value (on POS REF page 2/3).....VERIFY

CPDLC Quick Reference Guides

CPDLC Operations

Use this table as a memory jogger regarding CPDLC related actions within normal procedures while operating CPDLC flights.

When	Who	Action
Preflight	F/O	FMC Initialization..... Complete
	F/O	Route, Winds Load, Execute
	C, F/O	RNP Verify / Correct On POS REF page 2/3, verify default or correct values set, if appropriate.
	F/O	ATC LOGON/STATUS Page Data Verify / Enter Verify / enter flight number <u>exactly</u> as shown on ICAO flight plan, registration number from SELCAL placard, and airline code CO.
	F/O	ATC Facility Code Enter And Send (If CPDLC logon available on ground)
Cruise	PM	ATC Facility Code Enter And Send (If not previously accomplished) Log on 15 – 45 minutes prior to FIR.
	PF, PM	RNP Verify correct for route segment, if applicable.
	PM	ATC COMM Monitor Use as necessary for clearances, requests, etc.
	PF	WINDS Request, update as necessary (After 0600Z and 1800Z)
Descent	PF, PM	RNP Verify RNP correct for route segment, or default, if applicable.

CPDLC Uplink Message Procedures

The following SOP is the expected response to an ATC CPDLC clearance.

Accomplish these steps carefully when responding to ATC uplink messages.

PF	MFD COMM Display Switch.....Select
PF, PM	Uplink Message.....Read Independently And Silently
PF, PM	Uplink Message..... Review, Discuss, Evaluate
PF	MCP / FMC.....Set / Load (do not execute)
PF, PM	MCP / FMC Entries Verify
PM	Uplink Data ACCEPT or REJECT
PF	MCP/FMC EntriesExecute, if applicable

Abbreviations / Acronyms

ACC	Area Control Center
ADS	Automatic Dependent Surveillance
AFN	ATS Facilities Notification
AFTN	Aeronautical Fixed Telecommunications Network
ANP	Actual Navigation Performance
ARINC	Aeronautical Radio Inc.
ATM	Air Traffic Management
ATS	Air Traffic Service
CADS	Central ADS System
CLA	Clearance
CNS	Communication, Navigation and Surveillance
CPDLC	Controller to Pilot Data Link Communications
DARPS	Dynamic Air Route Planning System
FANS	Future Air Navigation System
FIR	Flight Information Region
GES	Ground Earth Station
GNSS	Global Navigation Satellite System
GP	General Purpose (radio relay service)
GPS	Global Positioning System
HGA	High Gain Antenna
INMARSAT	International Maritime Satellite
LDOC	Long Distance Operational Control
LGA	Low Gain Antenna
NAR	North American Route
OCA	Oceanic Control Area
OCD	Oceanic Clearance Delivery
PETAL	Preliminary European Trials of Air Ground Data Link
RCL	Request Clearance
RNP	Required Navigation Performance
RTA	Required Time Of Arrival
SATCOM	Satellite Communication
TDM	Track Detail Message
UAC	Upper Airspace Control

INTENTIONALLY LEFT BLANK

CPDLC MESSAGES

CPDLC Message Intent

This section contains a complete listing of all “canned” CPDLC message elements, and a description of the message intent. The Message Intent column is a legal description of the official message intent (meaning) for the Message Element column. The UL and DL numbers are simply used for reference purposes to identify a specific message / group and are not necessarily in sequence.

Response Requirements Key

TYPE	CLOSURE RESPONSES
W/U	WILCO ACPT or UNABLE RJCT will close the uplink message.
A/N	AFFIRM ACPT or NEGATIVE RJCT will close the uplink message.
R	ROGER, will close the uplink message.
NE	Most messages with an NE attribute require an operational response. Only the correct operational response is presented to the pilot. The uplink message is considered to be closed on sending and does not require a response to close the dialogue. The WILCO, UNABLE, AFFIRM, NEGATIVE, ROGER, and STANDBY responses are not enabled for pilot selection.
Y	Response required.
N	Response not required.

Note: Under some circumstances, an **ERROR** message will also close an uplink message.

Uplink (UL) - Responses And Acknowledgements

UL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
0	UNABLE	Indicates that ATS cannot comply with the request.	NE
1	STANDBY	Indicates that ATS has received the message and will respond. <i>The pilot is informed that the request is being assessed and there will be a <u>short-term delay</u> (within 10 minutes). The exchange is not closed and the request will be responded to when conditions allow.</i>	NE
2	REQUEST DEFERRED	Indicates that ATS has received the request but it has been deferred until later. <i>The pilot is informed that the request is being assessed and a <u>long-term delay</u> can be expected. The exchange is not closed and the request will be responded to when conditions allow.</i>	NE
3	ROGER	Indicates that ATS has received and understood the message.	NE
4	AFFIRM	Yes	NE
5	NEGATIVE	No	NE

Uplink (UL) - Vertical Clearances

UL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
6	EXPECT [altitude]	Notification that a level change instruction should be expected.	R
7	EXPECT CLIMB AT [time]	Notification that an instruction should be expected for the aircraft to commence climb at the specified time.	R
8	EXPECT CLIMB AT [position]	Notification that an instruction should be expected for the aircraft to commence climb at the specified position.	R
9	EXPECT DESCENT AT [time]	Notification that an instruction should be expected for the aircraft to commence descent at the specified time.	R
10	EXPECT DESCENT AT [position]	Notification that an instruction should be expected for the aircraft to commence descent at the specified position.	R
11	EXPECT CRUISE CLIMB AT [time]	Notification that an instruction should be expected for the aircraft to commence cruise climb at the specified time. <i>Due to different interpretations between the various ATS units this element should be avoided.</i>	R
12	EXPECT CRUISE CLIMB AT [position]	Notification that an instruction should be expected for the aircraft to commence cruise climb at the specified position. <i>Due to different interpretations between the various ATS units this element should be avoided.</i>	R
13	AT [time] EXPECT CLIMB TO [altitude]	Notification that an instruction should be expected for the aircraft to commence climb at the specified time to the specified level.	R
14	AT [position] EXPECT CLIMB TO [altitude]	Notification that an instruction should be expected for the aircraft to commence climb at the specified position to the specified level.	R
15	AT [time] EXPECT DESCENT TO [altitude]	Notification that an instruction should be expected for the aircraft to commence descent at the specified time to the specified level.	R
16	AT [position] EXPECT DESCENT TO [altitude]	Notification that an instruction should be expected for the aircraft to commence descent at the specified position to the specified level.	R
17	AT [time] EXPECT CRUISE CLIMB TO [altitude]	Notification that an instruction should be expected for the aircraft to commence cruise climb at the specified time to the specified level. <i>Due to different interpretations between the various ATS units, this element should be avoided.</i>	R
18	AT [position] EXPECT CRUISE CLIMB TO [altitude]	Notification that an instruction should be expected for the aircraft to commence cruise climb at the specified position to the specified level. <i>Due to different interpretations between the various ATS units, this element should be avoided.</i>	R

19	MAINTAIN [altitude]	Instruction to maintain the specified level.	W/U
20	CLIMB TO AND MAINTAIN [altitude]	Instruction that a climb to the specified level is to commence and the level is to be maintained when reached.	W/U
21	AT [time] CLIMB TO AND MAINTAIN [altitude]	Instruction that at the specified time, a climb to the specified level is to commence and once reached the specified level is to be maintained.	W/U
22	AT [position] CLIMB TO AND MAINTAIN [altitude]	Instruction that at the specified position, a climb to the specified level is to commence and once reached the specified level is to be maintained.	W/U
23	DESCEND TO AND MAINTAIN [altitude]	Instruction that a descent to the specified level is to commence and the level is to be maintained when reached.	W/U
24	AT [time] DESCEND TO AND MAINTAIN [altitude]	Instruction that at the specified time a descent to the specified level is to commence and once reached the specified level is to be maintained.	W/U
25	AT [position] DESCEND TO AND MAINTAIN [altitude]	Instruction that at the specified position a descent to the specified level is to commence and when the specified level is reached it is to be maintained.	W/U
26	CLIMB TO REACH [altitude] BY [time]	Instruction that a climb is to commence at a rate such that the specified level is reached at or before the specified time.	W/U
27	CLIMB TO REACH [altitude] BY [position]	Instruction that a climb is to commence at a rate such that the specified level is reached at or before the specified position.	W/U
28	DESCEND TO REACH [altitude] BY [time]	Instruction that a descent is to commence at a rate such that the specified level is reached at or before the specified time.	W/U
29	DESCEND TO REACH [altitude] BY [position]	Instruction that a descent is to commence at a rate such that the specified level is reached at or before the specified position.	W/U
30	MAINTAIN BLOCK [altitude] TO [altitude]	A level within the specified vertical range is to be maintained.	W/U

31	CLIMB TO AND MAINTAIN BLOCK [altitude] TO [altitude]	Instruction that a climb to a level within the specified vertical range is to commence.	W/U
32	DESCEND TO AND MAINTAIN BLOCK [altitude] TO [altitude]	Instruction that a descent to a level within the specified vertical range is to commence.	W/U
33	CRUISE [altitude]	Instruction that authorizes a pilot to conduct flight at any altitude from the minimum altitude up to and including the altitude specified in the clearance. Further, it is approval for the pilot to proceed to and make an approach at the destination airport. <i>This element will only be used in the Oakland FIR.</i>	
34	CRUISE CLIMB TO [altitude]	A cruise climb is to commence and continue until the specified level is reached. <i>Due to different interpretations between the various ATS units, this element should be avoided.</i>	W/U
35	CRUISE CLIMB ABOVE [altitude]	A cruise climb can commence once above the specified level. <i>Due to different interpretations between the various ATS units, this element should be avoided.</i>	W/U
36	EXPEDITE CLIMB TO [altitude]	The climb to the specified level should be made at the aircraft's best rate.	W/U
37	EXPEDITE DESCENT TO [altitude]	The descent to the specified level should be made at the aircraft's best rate.	W/U
38	IMMEDIATELY CLIMB TO [altitude]	Urgent instruction to immediately climb to the specified level.	W/U
39	IMMEDIATELY DESCEND TO [altitude]	Urgent instruction to immediately descend to the specified level.	W/U
40	IMMEDIATELY STOP CLIMB AT [altitude]	Urgent instruction to immediately stop a climb once the specified level is reached.	W/U
41	IMMEDIATELY STOP DESCENT AT [altitude]	Urgent instruction to immediately stop a descent once the specified level is reached.	W/U

171	CLIMB AT [vertical rate] MINIMUM	Instruction to climb at not less than the specified rate	W/U
172	CLIMB AT [vertical rate] MAXIMUM	Instruction to climb at not above the specified rate.	W/U
173	DESCEND AT [vertical rate] MINIMUM	Instruction to descend at not less than the specified rate.	W/U
174	DESCEND AT [vertical rate] MAXIMUM	Instruction to descend at not above the specified rate.	W/U

Uplink (UL) - Crossing Constraints

UL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
42	EXPECT TO CROSS [position] AT [altitude]	Notification that a level change instruction should be expected which will require the specified position to be crossed at the specified level.	R
43	EXPECT TO CROSS [position] AT OR ABOVE [altitude]	Notification that a level change instruction should be expected which will require the specified position to be crossed at or above the specified level.	R
44	EXPECT TO CROSS [position] AT OR BELOW [altitude]	Notification that a level change instruction should be expected which will require the specified position to be crossed at or below the specified level.	R
45	EXPECT TO CROSS [position] AT AND MAINTAIN [altitude]	Notification that a level change instruction should be expected which will require the specified position to be crossed at the specified level which is to be maintained subsequently.	R
46	CROSS [position] AT [altitude]	The specified position is to be crossed at the specified level. This may require the aircraft to modify its climb or descent profile.	W/U
47	CROSS [position] AT OR ABOVE [altitude]	The specified position is to be crossed at or above the specified level.	W/U
48	CROSS [position] AT OR BELOW [altitude]	The specified position is to be crossed at or below the specified level.	W/U
49	CROSS [position] AT AND MAINTAIN [altitude]	Instruction that the specified position is to be crossed at the specified level and that level is to be maintained when reached.	W/U
50	CROSS [position] BETWEEN [altitude] AND [altitude]	The specified position is to be crossed at a level between the specified levels.	W/U
51	CROSS [position] AT [time]	The specified position is to be crossed at the specified time.	W/U
52	CROSS [position] AT OR BEFORE [time]	The specified position is to be crossed at or before the specified time.	W/U

53	CROSS [position] AT OR AFTER [time]	The specified position is to be crossed at or after the specified time.	W/U
54	CROSS [position] BETWEEN [time] AND [time]	The specified position is to be crossed at a time between the specified times.	W/U
55	CROSS [position] AT [speed]	The specified position is to be crossed at the specified speed and the specified speed is to be maintained until further advised.	W/U
56	CROSS [position] AT OR LESS THAN [speed]	The specified position is to be crossed at a speed equal to or less than the specified speed and the specified speed or less is to be maintained until further advised.	W/U
57	CROSS [position] AT OR GREATER THAN [speed]	The specified position is to be crossed at a speed equal to or greater than the specified speed and the specified speed or greater is to be maintained until further advised.	W/U
58	CROSS [position] AT [time] AT [altitude]	The specified position is to be crossed at the specified time and the specified level.	W/U
59	CROSS [position] AT OR BEFORE [time] AT [altitude]	The specified position is to be crossed at or before the specified time and at the specified level.	W/U
60	CROSS [position] AT OR AFTER [time] AT [altitude]	The specified position is to be crossed at or after the specified time and at the specified level.	W/U
61	CROSS [position] AT AND MAINTAIN [altitude] AT [speed]	Instruction that the specified position is to be crossed at the specified level and speed and the level and speed are to be maintained.	W/U
62	AT [time] CROSS [position] AT AND MAINTAIN [altitude]	Instruction that at the specified time the specified position is to be crossed at the specified level and the level is to be maintained.	W/U
63	AT [time] CROSS [position] AT AND MAINTAIN [altitude] AT [speed]	Instruction that at the specified time the specified position is to be crossed at the specified level and speed and the level and speed are to be maintained.	W/U

Uplink (UL) - Lateral Offsets

UL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
64	OFFSET [direction] [distance offset] OF ROUTE	Instruction to fly a parallel track to the cleared route at a displacement of the specified distance in the specified direction.	W/U
65	AT [position] OFFSET [direction] [distance offset] OF ROUTE	Instruction to fly a parallel track to the cleared route at a displacement of the specified distance in the specified direction and commencing at the specified position.	W/U
66	AT [time] OFFSET [direction] [distance offset] OF ROUTE	Instruction to fly a parallel track to the cleared route at a displacement of the specified distance in the specified direction and commencing at the specified time.	W/U
67	PROCEED BACK ON ROUTE	The cleared flight route is to be rejoined.	W/U
68	REJOIN ROUTE BY [position]	The cleared flight route is to be rejoined at or before the specified position.	W/U
69	REJOIN ROUTE BY [time]	The cleared flight route is to be rejoined at or before the specified time.	W/U
70	EXPECT BACK ON ROUTE BY [position]	Notification that a clearance may be issued to enable the aircraft to rejoin the cleared route at or before the specified position.	R
71	EXPECT BACK ON ROUTE BY [time]	Notification that a clearance may be issued to enable the aircraft to rejoin the cleared route at or before the specified time.	R
72	RESUME OWN NAVIGATION	Instruction to resume own navigation following a period of tracking or heading clearances. May be used in conjunction with an instruction on how or where to rejoin the cleared route.	W/U

Uplink (UL) - Route Modifications

UL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
73	[predeparture clearance]	Notification to the aircraft of the instructions to be followed from departure until the specified clearance limit.	W/U
74	PROCEED DIRECT TO [position]	Instruction to proceed directly from the present position to the specified position.	W/U
75	WHEN ABLE PROCEED DIRECT TO [position]	Instruction to proceed, when able, directly to the specified position.	W/U
76	AT [time] PROCEED DIRECT TO [position]	Instruction to proceed, at the specified time, directly to the specified position.	W/U
77	AT [position] PROCEED DIRECT TO [position]	Instruction to proceed, at the specified position, directly to the next specified position.	W/U
78	AT [altitude] PROCEED DIRECT TO [position]	Instruction to proceed, upon reaching the specified level, directly to the specified position.	W/U
79	CLEARED TO [position] VIA [route clearance]	Instruction to proceed to the specified position via the specified route.	W/U
80	CLEARED [route clearance]	Instruction to proceed via the specified route.	W/U
81	CLEARED [procedure name]	Instruction to proceed in accordance with the specified procedure.	W/U
82	CLEARED TO DEVIATE UP TO [direction] [distance offset] OF ROUTE	Approval to deviate up to the specified distance from the cleared route in the specified direction.	W/U
83	AT [position] CLEARED [route clearance]	Instruction to proceed from the specified position via the specified route.	W/U
84	AT [position] CLEARED [procedure name]	Instruction to proceed from the specified position via the specified procedure.	W/U
85	EXPECT [route clearance]	Notification that a clearance to fly on the specified route may be issued.	R
86	AT [position] EXPECT [route clearance]	Notification that a clearance to fly on the specified route from the specified position may be issued.	R
87	EXPECT DIRECT TO [position]	Notification that a clearance to fly directly to the specified position may be issued.	R

88	AT [position] EXPECT DIRECT TO [position]	Notification that a clearance to fly directly from the first specified position to the next specified position may be issued.	R
89	AT [time] EXPECT DIRECT TO [position]	Notification that a clearance to fly directly to the specified position commencing at the specified time may be issued.	R
90	AT [altitude] EXPECT DIRECT TO [position]	Notification that a clearance to fly directly to the specified position commencing when the specified level is reached may be issued.	R
91	HOLD AT [position] MAINTAIN [altitude] INBOUND TRACK [degrees][direction] TURN LEG TIME [leg type]	Instruction to enter a holding pattern with the specified characteristics at the specified position and level.	W/U
92	HOLD AT [position] AS PUBLISHED MAINTAIN [altitude]	Instruction to enter a holding pattern with the published characteristics at the specified position and level.	W/U
93	EXPECT FURTHER CLEARANCE AT [time]	Notification that an onwards clearance may be issued at the specified time.	R
94	TURN [direction] HEADING [degrees]	Instruction to turn left or right as specified onto the specified heading.	W/U
95	TURN [direction] GROUND TRACK [degrees]	Instruction to turn left or right as specified onto the specified track.	W/U
96	FLY PRESENT HEADING	Instruction to continue to fly on the current heading.	W/U
97	AT [position] FLY HEADING [degrees]	Instruction to fly on the specified heading from the specified position.	W/U
98	IMMEDIATELY TURN [direction] HEADING [degrees]	Instruction to turn immediately left or right as specified onto the specified heading.	W/U
99	EXPECT [procedure name]	Notification that a clearance may be issued for the aircraft to fly the specified procedure.	R
178	TRACK DETAIL MESSAGE	<i>Message not defined.</i>	

Uplink (UL) - Speed Changes

UL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
100	AT [time] EXPECT [speed]	Notification that a speed instruction may be issued to be effective at the specified time.	R
101	AT [position] EXPECT [speed]	Notification that a speed instruction may be issued to be effective at the specified position.	R
102	AT [altitude] EXPECT [speed]	Notification that a speed instruction may be issued to be effective at the specified level.	R
103	AT [time] EXPECT [speed] TO [speed]	Notification that a speed range instruction may be issued to be effective at the specified time.	R
104	AT [position] EXPECT [speed] TO [speed]	Notification that a speed range instruction may be issued to be effective at the specified position.	R
105	AT [altitude] EXPECT [speed] TO [speed]	Notification that a speed range instruction may be issued to be effective at the specified level.	R
106	MAINTAIN [speed]	The specified speed is to be maintained.	W/U
107	MAINTAIN PRESENT SPEED	The present speed is to be maintained.	W/U
108	MAINTAIN [speed] OR GREATER	The specified speed or a greater speed is to be maintained.	W/U
109	MAINTAIN [speed] OR LESS	The specified speed or a lesser speed is to be maintained.	W/U
110	MAINTAIN [speed] TO [speed]	A speed within the specified range is to be maintained.	W/U
111	INCREASE SPEED TO [speed]	The present speed is to be increased to the specified speed and maintained until further advised.	W/U
112	INCREASE SPEED TO [speed] OR GREATER	The present speed is to be increased to the specified speed or greater, and maintained at or above the specified speed until further advised.	W/U
113	REDUCE SPEED TO [speed]	The present speed is to be reduced to the specified speed and maintained until further advised.	W/U
114	REDUCE SPEED TO [speed] OR LESS	The present speed is to be reduced to the specified speed or less and maintained at or below the specified speed until further advised.	W/U
115	DO NOT EXCEED [speed]	The specified speed is not to be exceeded.	W/U
116	RESUME NORMAL SPEED	Notification that the aircraft need no longer comply with the previously issued speed restriction.	W/U

Uplink (UL) – Contact / Monitor / Surveillance Requests

UL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
117	CONTACT [icaounitname][frequency]	The pilot is required to call the ATS facility on the specified frequency.	W/U
118	AT [position] CONTACT [icaounitname] [frequency]	At the specified position the ATS unit with the specified ATS unit name is to be contacted on the specified frequency.	W/U
119	AT [time] CONTACT [icaounitname] [frequency]	At the specified time the ATS unit with the specified ATS unit name is to be contacted on the specified frequency.	W/U
120	MONITOR [icaounitname][frequency]	The pilot is required to monitor the specified ATS facility on the specified frequency. <i>The Pilot is not required to check in.</i>	W/U
121	AT [position] MONITOR [icaounitname] [frequency]	At the specified position the ATS unit with the specified ATS unit name is to be monitored on the specified frequency.	W/U
122	AT [time] MONITOR [icaounitname] [frequency]	At the specified time the ATS unit with the specified ATS unit name is to be monitored on the specified frequency.	W/U
123	SQUAWK [beacon code]	The specified code (SSR code) is to be selected.	W/U
124	STOP SQUAWK	The SSR transponder responses are to be disabled.	W/U
125	SQUAWK ALTITUDE	The SSR transponder responses should include level information.	W/U
126	STOP ALTITUDE SQUAWK	The SSR transponder responses should no longer include level information.	W/U
179	SQUAWK IDENT	The 'ident' function on the SSR transponder is to be actuated.	W/U

Uplink (UL) – Report / Confirmation Requests

UL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
127	REPORT BACK ON ROUTE	Instruction to report when the aircraft is back on the cleared route.	R
128	REPORT LEAVING [altitude]	Instruction to report when the aircraft has left the specified level. <i>Either a level that has been maintained, or a level passed through on climb or descent.</i>	R
129	REPORT LEVEL [altitude]	Instruction to report when the aircraft is in level flight at the specified level.	R
175	REPORT REACHING [altitude]	Instruction to report when the aircraft has reached the specified level. <i>To be interpreted as "Report reaching an assigned level."</i>	R
180	REPORT REACHING BLOCK [altitude] TO [altitude]	Instruction to report when the aircraft is within the specified vertical range.	R
130	REPORT PASSING [position]	Instruction to report when the aircraft has passed the specified position.	R
181	REPORT DISTANCE [to/from] [position]	Instruction to report the present distance to or from the specified position.	NE
131	REPORT REMAINING FUEL AND SOULS ON BOARD	Instruction to report the amount of fuel remaining and the number of persons on board.	NE
132	CONFIRM POSITION	Instruction to report the present position.	NE
133	CONFIRM ALTITUDE	Instruction to report the present level.	NE
134	CONFIRM SPEED	Instruction to report the present speed.	NE
135	CONFIRM ASSIGNED ALTITUDE	Instruction to confirm and acknowledge the currently assigned level.	NE
136	CONFIRM ASSIGNED SPEED	Instruction to confirm and acknowledge the currently assigned speed.	NE
137	CONFIRM ASSIGNED ROUTE	Instruction to confirm and acknowledge the currently assigned route.	NE
138	CONFIRM TIME OVER REPORTED WAYPOINT	Instruction to confirm the previously reported time over the last reported waypoint.	NE
139	CONFIRM REPORTED WAYPOINT	Instruction to confirm the identity of the previously reported waypoint.	NE
140	CONFIRM NEXT WAYPOINT	Instruction to confirm the identity of the next waypoint.	NE
141	CONFIRM NEXT WAYPOINT ETA	Instruction to confirm the previously reported estimated time at the next waypoint.	NE
142	CONFIRM ENSUING WAYPOINT	Instruction to confirm the identity of the next plus one waypoint.	NE
143	CONFIRM REQUEST	The request was not understood. It should be clarified and resubmitted.	NE
144	CONFIRM SQUAWK	Instruction to report the currently selected transponder code.	NE

145	CONFIRM HEADING	Instruction to report the present heading.	NE
146	CONFIRM GROUND TRACK	Instruction to report the present ground track.	NE
182	CONFIRM ATIS CODE	Instruction to report the identification code of the last ATIS received.	NE
147	REQUEST POSITION REPORT	Instruction to make a position report. <i>To be used if the controller does not receive a scheduled position report.</i>	NE

Uplink (UL) - Negotiation Requests

UL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
148	WHEN CAN YOU ACCEPT [altitude]	Request for the earliest time at which the specified level can be accepted.	NE
149	CAN YOU ACCEPT [altitude] AT [position]	Instruction to report whether or not the specified level can be accepted at the specified position.	A/N
150	CAN YOU ACCEPT [altitude] AT [time]	Instruction to report whether or not the specified level can be accepted at the specified time.	A/N
151	WHEN CAN YOU ACCEPT [speed]	Instruction to report the earliest time when the specified speed can be accepted.	NE
152	WHEN CAN YOU ACCEPT [direction] [distance offset] OFFSET	Instruction to report the earliest time when the specified offset track can be accepted.	NE

Uplink (UL) - Air Traffic Advisories

UL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
153	ALTIMETER [altimeter]	ATS advisory that the altimeter setting should be the specified setting.	R
154	RADAR SERVICES TERMINATED	ATS advisory that the radar service is terminated.	R
155	RADAR CONTACT [position]	ATS advisory that radar contact has been established at the specified position.	R
156	RADAR CONTACT LOST	ATS advisory that radar contact has been lost.	R
157	CHECK STUCK MICROPHONE [frequency]	A continuous transmission is detected on the specified frequency. Check the microphone button.	R
158	ATIS [atis code]	ATS advisory that the ATIS information identified by the specified code is the current ATIS information.	R

Uplink (UL) - System Management Messages

UL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
159	ERROR [error information]	A system generated message that the ground system has detected an error.	NE
160	NEXT DATA AUTHORITY [facility designation]	Notification to the avionics that the next data authority is the specified ATSU.	NE
161	END SERVICE	Notification to the avionics that the data link connection with the current data authority is being terminated.	NE
162	SERVICE UNAVAILABLE	Notification that the ground system does not support this message.	NE
163	[icao facility designation] [tp4Table]	Notification to the pilot of an ATSU identifier.	NE

Uplink (UL) - Additional Messages

UL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
164	WHEN READY	The associated instruction may be complied with at any future time.	NE
165	THEN	Used to link two messages, indicating the proper order of execution of clearances/ instructions.	NE
166	DUE TO TRAFFIC	The associated instruction is issued due to traffic considerations.	NE
167	DUE TO AIRSPACE RESTRICTION	The associated instruction is issued due to airspace restrictions.	NE
168	DISREGARD	The indicated communication should be ignored. <i>The previously sent uplink CPDLC message shall be ignored. DISREGARD should not refer to a clearance or instruction. If DISREGARD is used, another element shall be added to clarify which message is to be disregarded.</i>	R
176	MAINTAIN OWN SEPARATION AND VMC	Notification that the pilot is responsible for maintaining separation from other traffic and is also responsible for maintaining Visual Meteorological Conditions.	W/U
177	AT PILOTS DISCRETION	Used in conjunction with a clearance or instruction to indicate that the pilot may execute when prepared to do so.	N
169	[free text]	<i>Normal urgency attribute</i>	R
170	[free text]	<i>Distress urgency attribute</i>	R

Downlink (DL) - Responses

DL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
0	WILCO	The instruction is understood and will be complied with.	N
1	UNABLE	The instruction cannot be complied with.	N
2	STANDBY	Wait for a reply. <i>The controller is informed that the request is being assessed and there will be a <u>short term</u> delay (within 10 minutes). The exchange is not closed and the request will be responded to when conditions allow.</i>	N
3	ROGER	Message received and understood. <i>ROGER is the only correct response to an uplink free text message. Under no circumstances will ROGER be used instead of AFFIRM.</i>	N
4	AFFIRM	Yes <i>AFFIRM is an appropriate response to an uplinked negotiation request message (e.g. CAN YOU ACCEPT [altitude] AT [time]).</i>	N
5	NEGATIVE	No <i>NEGATIVE is an appropriate response to an uplinked negotiation request message (e.g. CAN YOU ACCEPT [altitude] AT [time]).</i>	N

Downlink (DL) - Vertical Requests

DL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
6	REQUEST [altitude]	Request to fly at the specified level.	Y
7	REQUEST BLOCK [altitude] TO [altitude]	Request to fly at a level within the specified vertical range.	Y
8	REQUEST CRUISE CLIMB TO [altitude]	Request to cruise climb to the specified level. <i>Due to different interpretations between the various ATS units, this element should be avoided.</i>	Y
9	REQUEST CLIMB TO [altitude]	Request to climb to the specified level.	Y
10	REQUEST DESCENT TO [altitude]	Request to descend to the specified level.	Y
11	AT [position] REQUEST CLIMB TO [altitude]	Request that at the specified position a climb to the specified level be approved.	Y
12	AT [position] REQUEST DESCENT TO [altitude]	Request that at the specified position a descent to the specified level be approved.	Y
13	AT [time] REQUEST CLIMB TO [altitude]	Request that at the specified time a climb to the specified level be approved.	Y
14	AT [time] REQUEST DESCENT TO [altitude]	Request that at the specified time a descent to the specified level be approved.	Y

Downlink (DL) - Lateral Off-Set Requests

DL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
15	REQUEST OFFSET [direction] [distance offset] OF ROUTE	Request that a parallel track, offset from the cleared track by the specified distance in the specified direction, be approved.	Y
16	AT [position] REQUEST OFFSET [direction] [distance offset] OF ROUTE	Request that a parallel track, offset from the cleared track by the specified distance in the specified direction, be approved from the specified position.	Y
17	AT [time] REQUEST OFFSET [direction] [distance offset] OF ROUTE	Request that a parallel track, offset from the cleared track by the specified distance in the specified direction, be approved from the specified time.	Y

Downlink (DL) - Speed Requests

DL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
18	REQUEST [speed]	Request to fly at the specified speed.	Y
19	REQUEST [speed] TO [speed]	Request to fly within the specified speed range.	Y

Downlink (DL) - Voice Contact Requests

DL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
20	REQUEST VOICE CONTACT	Request for voice contact.	Y
21	REQUEST VOICE CONTACT [frequency]	Request for voice contact on the specified frequency.	Y

Downlink (DL) - Route Modification Requests

DL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
22	REQUEST DIRECT TO [position]	Request to track from the present position direct to the specified position.	Y
23	REQUEST [procedure name]	Request for the specified procedure clearance.	Y
24	REQUEST [route clearance]	Request for a route clearance.	Y
25	REQUEST CLEARANCE	Request for either a pre-departure or route clearance.	Y
26	REQUEST WEATHER DEVIATION TO [position] VIA [route clearance]	Request for a weather deviation to the specified position via the specified route.	Y
27	REQUEST WEATHER DEVIATION UP TO [direction] [distance offset] OF ROUTE	Request for a weather deviation up to the specified distance off track in the specified direction.	Y
70	REQUEST HEADING [degrees]	Request a clearance to adopt the specified heading.	Y
71	REQUEST GROUND TRACK [degrees]	Request a clearance to adopt the specified ground track.	Y

Downlink (DL) - Reports

DL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
28	LEAVING [altitude]	Notification of leaving the specified level.	N
29	CLIMBING TO [altitude]	Notification of climbing to the specified level.	N
30	DESCENDING TO [altitude]	Notification of descending to the specified level.	N
31	PASSING [position]	Notification of passing the specified position.	N
78	AT [time] [distance] [to/from] [position]	At the specified time, the aircraft's position was as specified.	N
32	PRESENT ALTITUDE [altitude]	Notification of the present level.	N
33	PRESENT POSITION [position]	Notification of the present position.	N
34	PRESENT SPEED [speed]	Notification of the present speed.	N
35	PRESENT HEADING [degrees]	Notification of the present heading in degrees.	N
36	PRESENT GROUND TRACK [degrees]	Notification of the present ground track in degrees.	N
37	LEVEL [altitude]	Notification that the aircraft is maintaining the specified level.	N
72	REACHING [altitude]	Notification that the aircraft has reached the specified level.	N
76	REACHING BLOCK [altitude] TO [altitude]	Notification that the aircraft has reached a level within the specified vertical range.	N
38	ASSIGNED ALTITUDE [altitude]	Read-back of the assigned level.	N
77	ASSIGNED BLOCK [altitude] TO [altitude]	Read-back of the assigned vertical range.	N
39	ASSIGNED SPEED [speed]	Read-back of the assigned speed.	N
40	ASSIGNED ROUTE [route clearance]	Read-back of the assigned route.	N
41	BACK ON ROUTE	The aircraft has regained the cleared route.	N
42	NEXT WAYPOINT [position]	The next waypoint is the specified position.	N
43	NEXT WAYPOINT ETA [time]	The ETA at the next waypoint is as specified.	N
44	ENSUING WAYPOINT [position]	The next plus one waypoint is the specified position.	N
45	REPORTED WAYPOINT [position]	Clarification of previously reported waypoint passage.	N
46	REPORTED WAYPOINT [time]	Clarification of time over previously reported waypoint.	N

47	SQUAWKING [beacon code]	The specified (SSR) code has been selected.	N
48	POSITION REPORT [position report]	Reports the current position of the aircraft when the pilot presses the button to send this message. <i>ATC expects position reports based on this downlink message.</i>	N
79	ATIS [atis code]	The code of the latest ATIS received is as specified.	N
80	DEVIATING [direction] [distance offset] OF ROUTE	Notification that the aircraft is deviating from the cleared route by the specified distance in the specified direction.	N

Downlink (DL) - Negotiation Requests

DL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
49	WHEN CAN WE EXPECT [speed]	Request for the earliest time at which a clearance to the specified speed can be expected.	Y
50	WHEN CAN WE EXPECT [speed] TO [speed]	Request for the earliest time at which a clearance to a speed within the specified range can be expected.	Y
51	WHEN CAN WE EXPECT BACK ON ROUTE	Request for the earliest time at which a clearance to regain the planned route can be expected.	Y
52	WHEN CAN WE EXPECT LOWER ALTITUDE	Request for the earliest time at which a clearance to descend can be expected.	Y
53	WHEN CAN WE EXPECT HIGHER ALTITUDE	Request for the earliest time at which a clearance to climb can be expected.	Y
54	WHEN CAN WE EXPECT CRUISE CLIMB TO [altitude]	Request for the earliest time at which a clearance to cruise climb to the specified level can be expected.	Y

Downlink (DL) - Emergency Messages

DL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
55	PAN PAN PAN	Urgency prefix.	N
56	MAYDAY MAYDAY MAYDAY	Distress prefix.	N
57	[remaining fuel] OF FUEL REMAINING AND [souls on board] SOULS ON BOARD	Notification of fuel remaining and number of persons on board.	N
58	CANCEL EMERGENCY	Notification that the pilot wishes to cancel the emergency condition.	N
59	DIVERTING TO [position] or DIVERTING TO [position] VIA [x]	Notification that the aircraft is diverting to the specified position via the specified route.	N
60	OFFSETTING [direction] [distance offset] OF ROUTE	Notification that the aircraft is deviating the specified distance in the specified direction off the cleared route and maintaining a parallel track.	N
61	DESCENDING TO [altitude]	Notification that the aircraft is descending to the specified level.	N

Downlink (DL) - System Management Messages

DL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
62	ERROR [error information]	A system generated message that the avionics has detected an error.	N
63	NOT CURRENT DATA AUTHORITY	A system generated denial to any CPDLC message sent from a ground facility that is not the Current Data Authority.	N
64	[icao facility designation]	Notification to the ground system that the specified ATSU is the current data authority.	N
73	[version number]	A system generated message indicating the software version number.	N

Downlink (DL) - Additional Messages

DL	MESSAGE ELEMENT	MESSAGE INTENT	RESPONSE
65	DUE TO WEATHER	Used to explain reasons for aircraft operator's message.	N
66	DUE TO AIRCRAFT PERFORMANCE	Used to explain reasons for aircraft operator's message.	N
74	MAINTAIN OWN SEPARATION AND VMC	States a desire by the pilot to provide his/her own separation and remain in VMC.	N
75	AT PILOTS DISCRETION	Used in conjunction with another message to indicate that the pilot wishes to execute the request when the pilot is prepared to do so.	N
67	[free text]	<i>Normal urgency attribute</i>	N
67b	WE CAN ACCEPT [altitude] AT [time]	We can accept the specified level at the specified time.	N
67c	WE CAN ACCEPT [speed] AT [time]	We can accept the specified speed at the specified time.	N
67d	WE CAN ACCEPT [direction] [distance offset] AT [time]	We can accept a parallel track offset the specified distance in the specified direction at the specified time.	N
67e	WE CANNOT ACCEPT [altitude]	We cannot accept the specified level.	N
67f	WE CANNOT ACCEPT [speed]	We cannot accept the specified speed.	N
67g	WE CANNOT ACCEPT [direction] [distance offset]	We cannot accept a parallel track offset the specified distance in the specified direction.	N
67h	WHEN CAN WE EXPECT CLIMB TO [altitude]	Request for the earliest time at which a clearance to climb to the specified level can be expected.	N
67i	WHEN CAN WE EXPECT DESCENT TO [altitude]	Request for the earliest time at which a clearance to descend to the specified level can be expected.	N
68	[free text]	<i>Distress urgency attribute.</i>	Y

CPDLC Standard - Free Text Messages

This section contains a complete listing of the standard FREE TEXT messages and intent for CPDLC.

Responding To A Standardized Free Text

When a free text uplink message has been received, the pilot shall respond with the **QUICK RESPONSE** from the table **before responding to the message**.

TYPE	CLOSURE RESPONSES
ROGER	ACPT will close the uplink message.
UNABLE or NEGATIVE	RJCT will close the uplink message.

Uplink - Free Text Report / Confirmation Requests

PERSON, ORDER, INTENT	FREE TEXT MESSAGE	QUICK RESPONSE
Controller	REPORT SIGHTING AND PASSING OPPOSITE DIRECTION [traffic description] ETP [time] <i>The traffic description is to be inserted by the controller and shall include the aircraft identification (call sign), flight level and aircraft type. ETP = Estimated Time of Passing.</i> <i>Example of the traffic description: SIA228 B747 FL370</i>	
Pilot Response	[traffic identification] SIGHTED AND PASSED <i>Example - SIA228 SIGHTED AND PASSED</i> Or [traffic identification] NOT SIGHTED	ROGER
Message Intent	The controller is requesting that the pilot notify when the specified traffic has been seen by visual contact and passed. The level specified in the traffic description is the level being maintained by the opposite direction aircraft.	

PERSON, ORDER, INTENT	FREE TEXT MESSAGE	QUICK RESPONSE
Controller	REPORT GROUND SPEED	
Pilot Response	G/S [speed] <i>Example - G/S 490</i>	ROGER
Message Intent	The controller is requesting that the pilot report the present ground speed.	

PERSON, ORDER, INTENT	FREE TEXT MESSAGE	QUICK RESPONSE
Controller	REQUEST PREFERRED FLIGHT LEVEL	
Pilot Response	FL [altitude] <i>Example - FL 350</i>	ROGER
Message Intent	The controller is requesting that the pilot advise the preferred flight level for the flight.	
Controller	REPORT ESTIMATE [place name / waypoint] <i>Example - REQUEST ESTIMATE BILBO</i>	
Pilot Response	[place name / waypoint] [time] <i>Example - BILBO 0413</i>	ROGER
Message Intent	The controller is requesting an estimate for the specified waypoint.	

PERSON, ORDER, INTENT	FREE TEXT MESSAGE	QUICK RESPONSE
Controller	WHEN WILL YOU MAINTAIN FL [altitude]	
Pilot Response	FL [altitude] AT [time] <i>Example - FL 350 AT 2317</i>	ROGER
Message Intent	The controller is requesting from the pilot the time at which the aircraft will maintain the specified level.	

PERSON, ORDER, INTENT	FREE TEXT MESSAGE	QUICK RESPONSE
Controller	AT WHAT DISTANCE [position / waypoint] WILL YOU MAINTAIN FL [altitude]	
Pilot Response	FL [altitude] AT [distance] NM [direction] [position / waypoint] <i>Example - FL 350 AT 26 NM W IPEMA</i>	ROGER
Message Intent	The controller is requesting the distance from the specified position or waypoint at which the aircraft will maintain the specified level. The pilot shall include the direction from the waypoint as a cardinal point, e.g. N, NE, NW, S, SW, SE, E or W.	

PERSON, ORDER, INTENT	FREE TEXT MESSAGE	QUICK RESPONSE
Controller	REPORT RADIAL AND DISTANCE [to/from] [position]	
Pilot Response	[radial] R [distance] NM [to/from] [position] <i>Example - 320 R 26 NM FROM MCY</i>	ROGER
Message Intent	The controller is requesting that the pilot report the radial on which the aircraft is proceeding and the distance from the specified VOR.	

PERSON, ORDER, INTENT	FREE TEXT MESSAGE	QUICK RESPONSE
Controller	REQUEST VOICE CONTACT [frequency]	
Pilot Response		ROGER
Message Intent	The controller is requesting that the pilot makes voice contact / radio check call on the specified frequency.	

Uplink - Free Text Instructions

PERSON, ORDER, INTENT	FREE TEXT MESSAGE	QUICK RESPONSE
Controller	CHECK ATC LOG PAGE FOR OPEN MESSAGES	
Pilot Response		ROGER
Message Intent	The controller has detected that uplink messages exist that the pilot has not yet responded to. The pilot is required to check the ATC log page and to respond to unanswered uplink messages.	

Uplink - Free Text Advisories

PERSON, ORDER, INTENT	FREE TEXT MESSAGE	QUICK RESPONSE
Controller	EXPECT SELCAL CHECK HF [frequency]	
Pilot Response		ROGER
Message Intent	The controller is notifying the pilot that a SELCAL check will be made on the specified HF frequency.	

PERSON, ORDER, INTENT	FREE TEXT MESSAGE	QUICK RESPONSE
Controller	EXPECT CPDLC TRANSFER AT [time]	
Pilot Response		ROGER
Message Intent	The controller is notifying the pilot that the CPDLC transfer process will not be completed at the FIR boundary and will be delayed until the specified time. If the CPDLC transfer is not completed by the specified time, the pilot shall manually disconnect and logon to the next center.	

PERSON, ORDER, INTENT	FREE TEXT MESSAGE	QUICK RESPONSE
Controller	EXPECT NEXT CENTER [ATSU name]. CONTACT WITH [ATSU name] NOT REQUIRED <i>The [ATSU name] is the relevant four character ICAO code.</i>	
Pilot Response		ROGER
Message Intent	The controller is notifying the pilot that CPDLC connection is not required by the next FIR (where the flight's transition time of that FIR is short) and CPDLC connection will be transferred to the subsequent FIR.	

PERSON, ORDER, INTENT	FREE TEXT MESSAGE	QUICK RESPONSE
Controller	TRAFFIC IS [traffic description]	
Pilot Response	(optional) TRAFFIC SIGHTED	ROGER
Message Intent	The controller is notifying the pilot of traffic significant to the flight. The description will include the aircraft type and any other relevant information to assist the pilot in sighting the traffic. The pilot may respond that the traffic has been sighted.	

PERSON, ORDER, INTENT	FREE TEXT MESSAGE	QUICK RESPONSE
Controller	SECONDARY HF [frequency]	
Pilot Response		ROGER
Message Intent	The controller is notifying the pilot of the secondary HF frequency for the area.	

Uplink - Free Text Speed Messages

PERSON, ORDER, INTENT	FREE TEXT MESSAGE	QUICK RESPONSE
Controller	EXPECT TO MAINTAIN [speed] UNTIL [time / position]	
Pilot Response		ROGER
Message Intent	The controller is notifying the pilot that a speed instruction may be issued to be effective until the specified time.	

Uplink - Free Text Emergency Acknowledgment

PERSON, ORDER, INTENT	FREE TEXT MESSAGE	QUICK RESPONSE
Controller	ROGER MAYDAY	
Pilot Response		ROGER
Message Intent	The controller has acknowledged receipt of a MAYDAY downlink message. The controller shall attempt to make voice contact with the pilot. The pilot should only respond with ROGER if or when able to do so. If the aircraft is inbound to an airport within the FIR, a ROGER response is not required.	

PERSON, ORDER, INTENT	FREE TEXT MESSAGE	QUICK RESPONSE
Controller	ROGER PAN	
Pilot Response		ROGER
Message Intent	The controller has acknowledged receipt of a PAN downlink message. The controller shall attempt to make voice contact with the pilot. The pilot should only respond with ROGER if or when able to do so. If the aircraft is inbound to an airport within the FIR, a ROGER response is not required.	

Downlink - Free Text Advisories

PERSON, ORDER, INTENT	FREE TEXT MESSAGE	RESPONSE
Pilot	WAKE DEV [direction] <i>Direction L or R (left or right) as appropriate</i>	
Controller Response		ROGER
Message Intent	The pilot is offsetting due wake turbulence in accordance with RVSM procedures (offset will not exceed 2nm). The controller is not required to respond or issue a clearance.	

PERSON, ORDER, INTENT	FREE TEXT MESSAGE	RESPONSE
Pilot	REVISED ETA [position] [time]	
Controller Response		ROGER
Message Intent	The pilot is advising ATC of an update a waypoint ETA.	

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ATC PAGES**Downlink Pages**

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
ATC		
ALTITUDE REQUEST	WHEN CAN WE EXPECT	EMERGENCY REPORT
ROUTE REQUEST	VOICE CONTACT REQUEST	ATC REQUESTED REPORTS...
SPEED REQUEST	LOGON / STATUS	POSITION REPORT
CLEARANCE REQUEST		FREE TEXT MESSAGE

77710014

The ATC main menu provides access to ATC downlink pages.

The ATC REQUESTED REPORTS menu selection is inhibited (cyan) when no reports are requested by ATC.

Note: This menu is not repeated when describing individual pages.

Altitude Request

The ALTITUDE REQUEST page allows selection of an altitude, an altitude block, or a VMC descent. A second request page allows selection of a reason for the request.

77710015

① ALTITUDE

The requested altitude is entered into the dash prompt and the SEND key becomes active.

Pushing the SEND key requests a normal climb at climb power unless otherwise requested.

Additional climb options are:

- STEP AT - Allows entering a time or position for the start of the climb
- CRUISE CLIMB - Begin a cruise climb from present position

STEP AT is inhibited when the ALTITUDE value is less than 150 feet from current aircraft altitude. Altitude entries are any valid FMC altitude. Time entries are in four digit, hours and minutes, optionally followed by a Z. Position entries are any valid FMC position.

② BLOCK

BLOCK is the beginning of a block altitude. TO is the end of the altitude block. Altitude entries are any valid FMC altitude.

The SEND key becomes active with an entry.

③ REQUEST VMC DESCENT

A VMC descent is begun from present position.

The SEND key becomes active with this selection.

① DIRECT TO

Enter any valid FMC waypoint. The SEND key becomes active with this selection.

② ROUTE

Selects FMC route 1 or 2. Sends the selected route, including any modifications. The SEND key becomes active with this selection.

③ HEADING

Enter desired heading. When displays are referenced to true north, a TRU label is displayed right of the heading. The SEND key becomes active with this selection.

④ GROUND TRACK

Enter desired ground track. When displays are referenced to true north, a TRU label is displayed right of the ground track. The SEND key becomes active with this selection.

⑤ DEP/ARR

Enter one of the following:

- Departure
- Arrival
- Departure and transition
- Arrival and transition.

Default entries are:

- Departure procedure / transition selected for the selected route
- The approach procedure / transition selected for the active route when the aircraft is in the air and an arrival procedure / transition is not selected.

The SEND key becomes active when one of the check boxes is selected.

⑥ WEATHER DEVIATION UP TO

Enter a three digit offset in nautical miles followed by the character L or R. The SEND key becomes active with this selection.

⑦ OFFSET

Enter any valid FMC route offset. The SEND key becomes active with this selection.

⑧ OFFSET AT

Enter a time or position to begin the offset. Time entries are in four digit, hours and minutes, optionally followed by a Z. Position entries are any valid FMC position.

Route Request Reason

A REQUEST REASON page is available as in ALTITUDE and SPEED. The reason page was previously described.

Speed Request

The SPEED REQUEST page allows selection of speed. A second request page allows selection of a reason for the request.

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z SPEED REQUEST		
① → SPEED: ----		<div>▲</div> <div>1</div> <div>2</div> <div>▼</div>
SEND	PRINT	RESET RETURN EXIT

77710018

① SPEED

Enter any valid FMC speed or mach number. IAS entries are rounded to the nearest 10 knots. The SEND key becomes active with this entry.

Speed Request Reason

A REQUEST REASON page is available as in ALTITUDE and ROUTE. The reason page was previously described.

Clearance Request

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z CLEARANCE REQUEST		
<div><input type="checkbox"/> REQUEST CLEARANCE</div>		
FREE TEXT: <div><div></div><div></div><div></div></div>		
SEND	PRINT	RESET RETURN EXIT

77710019

Selecting REQUEST CLEARANCE informs ATC that the crew is ready for a clearance, such as predeparture or pushback. Up to three lines of free text can be included. The SEND key becomes active with this selection.

The CLEARANCE REQUEST feature is **not currently used** in FANS operations.

Combination Downlink Request

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z	ALTITUDE REQUEST	
◆ ALTITUDE: FL330		
◆ STEP AT: -----		
◆ CRUISE CLIMB		
SEND	PRINT	RESET RETURN EXIT

1234Z	SPEED REQUEST	
.84		
VERIFY	PRINT	RESET RETURN EXIT

1234Z	VERIFY REQUEST	
REQUEST CRUISE CLIMB TO FL 330, .84		
SEND	PRINT	RESET RETURN EXIT

77710020

Requests from the ROUTE REQUEST, ALTITUDE REQUEST, and SPEED REQUEST pages can be combined into one downlink request. Each request is individually selected and filled out. Select subsequent request pages by selecting RETURN, and selecting additional downlink pages from the ATC main menu. When data is entered into the second request page, the SEND key changes to **VERIFY**.

The SEND key is active on the VERIFY REQUEST page. A combined request is limited to five elements. Selecting a sixth request element displays the MESSAGE LIMIT EXCEEDED information message.

The VERIFY REQUEST page provides a display of the combined request elements. Each element is displayed on separate lines. Elements requiring revision before sending are revised on their respective request page. Selecting SEND transmits the combined downlink message to ATC.

The example shows a combined altitude and speed request. The altitude request is created first.

When Can We Expect

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES

1234Z

WHEN CAN WE EXPECT

☐

ALTITUDE:

☐CRUISE CLIMB

☐HIGHER ALT

☐LOWER ALT:

☐SPEED:

☐BACK ON ROUTE

FREE TEXT:

SEND

PRINT

RESET

RETURN

EXIT

77710021

Making selections asks ATC the time or location the crew can expect clearance for the requested items. ALTITUDE, SPEED, and CRUISE CLIMB entry rules are the same as on the ALTITUDE REQUEST and SPEED REQUEST pages. Up to three lines of free text can be included. The SEND key becomes active when a check box is selected.

Voice Contact Request

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z VOICE CONTACT REQUEST		
<input type="checkbox"/> REQUEST VOICE CONTACT		
FREE TEXT: <input type="text"/>		
<input type="text"/>		
<input type="text"/>		
SEND	PRINT	RESET RETURN EXIT

77710022

Making selection asks ATC for a voice contact. Up to three lines of free text can be included. The **SEND** key becomes active when the request for voice contact box is selected.

Logon / Status

The LOGON/STATUS page allows the entry of the desired ATC facility for establishment of a data link connection.

The SEND key is displayed after all logon entries are completed. Selecting the SEND key displays **SENDING** status during logon transmission. Five seconds after the logon status changes to **SENT**, the page is exited.

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z	LOGON / STATUS	
① → ACTIVE CENTER:		
② → NEXT CENTER:		
③ →	ATC CONNECTION: NOT ESTABLISHED	
④ →	LOGON TO: KOAK	
⑤ →	FLIGHT NUMBER: COA09	
⑥ →	TAIL NUMBER: N78005	AIRLINE: CO ← ⑦
SEND	RESET	RETURN EXIT

77710023

① ACTIVE CENTER

Displays the ATC facility identifier where a connection is established.

② NEXT CENTER

Displays the ATC facility identifier to which an automatic handoff transfers the connection.

③ ATC CONNECTION

Displays the status of the ATC connection, ESTABLISHED OR NOT ESTABLISHED.

④ LOGON TO

Box prompts are initially displayed. Enter the ICAO four letter identifier for the desired ATC center. The display changes to dashed prompts after establishing an ATC connection.

⑤ FLIGHT NUMBER

Normally displays the flight number entered on the FMC route page. When the flight number is not available, box prompts are displayed. Flight number entry on this page is copied to the FMC route page. Changing this entry after establishing an ATC connection cancels the ATC connection.

Note: The flight number must be preceded by COA (the filing ID for Continental ICAO flight plans), and contain *no leading zeros* (unless the ICAO flight plan contains zeros).

⑥ TAIL NUMBER

Normally supplied by the aircraft system. When the aircraft tail number is not available to the system, box prompts are displayed. Changing this entry after establishing an ATC connection cancels the ATC connection. Tail number is provided on the SELCAL placard.

Note: The full “N” number registration must appear or be entered in the tail number box.

⑦ AIRLINE

Normally supplied by the system. When the airline identifier is not available to the system, box prompts are displayed. Changing this entry after establishing an ATC connection cancels the ATC connection.

Note: The airline code is CO.

ATC Connection Displays

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES

1234Z LOGON / STATUS

ACTIVE CENTER: KOAK

NEXT CENTER:

ATC CONNECTION: ESTABLISHED

LOGON TO: ----

FLIGHT NUMBER: BOE456

TAIL NUMBER: N7771 AIRLINE: BO

① → ☒ ATC DATA LINK OFF → CONFIRM OFF ← ②

RESET RETURN EXIT

MFD

77710024

① ATC DATA LINK OFF

Displayed when an ATC connection is established.

Selecting ATC DATA LINK OFF displays the CONFIRM OFF selection.

② CONFIRM OFF

Selecting CONFIRM OFF sends the termination request.

The EICAS **ATC DATA LINK LOST** message is displayed when the connection is terminated.

Loss of ATC Connection

If the EICAS advisory message **DATA LINK LOST** is displayed for 16 minutes, the ATC connection is automatically lost and the EICAS advisory message **ATC DATA LINK LOST** is displayed.

Once an ATC connection is terminated or lost, the logon entries revert to the default values.

Emergency Report

This page informs ATC of an emergency. Sending this report places automatic dependent surveillance (ADS) into the emergency mode.

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z	EMERGENCY REPORT	
① → MAYDAY	① → PAN	① → CANCEL EMERGENCY
② → DIVERTING TO: _____	VIA ROUTE X	
③ → FUEL REMAINING _____		
④ → _____	HOURS+MINUTES	
⑤ → SOULS ON BOARD: ---		
⑥ → DESCENDING TO: -----		
⑦ → OFFSETTING: ---		
⑧ → FREE TEXT: -----		
SEND	PRINT	RESET RETURN EXIT

77710025

- ① MAYDAY, PAN, CANCEL EMERGENCY

Select MAYDAY or PAN emergency. The **SEND** key becomes active. CANCEL EMERGENCY informs ATC that a previous emergency is now canceled and returns ADS to the normal mode. CANCEL EMERGENCY is inhibited until MAYDAY or PAN downlink is sent.

- ② DIVERTING TO

Defaults to the destination airport from the active route. The default route number is displayed. Enter any valid FMC position.

- ③ FUEL REMAINING

Displays the FMC fuel remaining from the PROGRESS page.

④ FUEL REMAINING - HOURS + MINUTES

Defaults to time provided from the FMC. Manually enter fuel remaining in hours and minutes. Use two numeric characters for hours followed by two numeric characters for minutes.

⑤ SOULS ON BOARD

Manual entry of number of souls on board is required. Enter up to three numeric characters.

⑥ DESCENDING TO

Enter the altitude for an immediate descent. The default value is the MCP altitude when it is more than 150 feet below current altitude.

⑦ OFFSETTING

Enter any valid FMC route offset value.

⑧ FREE TEXT

24 characters of free text can be included.

ATC Reports

ATC Requested Report

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1230Z ATC UPLINK		
CLIMB TO AND MAINTAIN FL330, REPORT REACHING FL330.		
DISPLAY REPORT		CANCEL

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
ATC REPORT		OPEN
REACHING FL330		
SEND	DELETE	PRINT
ARM	RETURN	CANCEL

77710026

ATC uplink messages can contain a request for a report. When the uplink is accepted, the **DISPLAY REPORT** key is displayed. Selecting **DISPLAY REPORT** displays the ATC requested report. A displayed report can be sent. Some reports can be armed for automatic transmission when conditions are met.

Armable Report

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
ATC		
ALTITUDE REQUEST	WHEN CAN WE EXPECT	EMERGENCY REPORT
ROUTE REQUEST	VOICE CONTACT REQUEST	ATC REQUESTED REPORTS...
SPEED REQUEST	LOGON / STATUS	POSITION REPORT
CLEARANCE REQUEST		FREE TEXT MESSAGE

ATC REPORT

ARMED

LEAVING FL330

ATC REPORT

ARMED

LEVEL FL330

ATC REPORT

ARMED

PASSING SEA

ATC REPORT

ARMED

REACHING FL330

77710027

All reports requested by ATC can be displayed using the ATC REQUESTED REPORT menu selection. The LEAVING, LEVEL, PASSING, and REACHING reports can be armed for automatic transmission. Selecting the ARM key for a report displays **ARMED** for the report status. When a report is ARMED, the ARM key changes to DISARM. When a report is automatically transmitted, an ATC uplink message confirms the report was sent.

Position Report

Use the POSITION REPORT page to manually send a position report.

ATC		FLIGHT INFORMATION		COMPANY	
REVIEW		MANAGER		NEW MESSAGES	
POSITION REPORT					
①	→ POS: 4038N12045E	ATA: 1234Z	←	⑦	
②	→ ALTITUDE: 32000 FT				1
③	→ EST: 4038N13045E	ETA: 1314Z	←	⑧	
④	→ NEXT: 4038N14045E				
		DEST ETA: 2200Z	←	⑨	2
⑤	→ .89	TEMP: -52C	←	⑩	
⑥	→ POS FUEL: xxx.xx X 1000	WIND: 145/030 KT	←	⑪	
SEND		PRINT		RESET RETURN EXIT	

77710028

① POS

Displays the last sequenced FMC waypoint. Displays all asterisks (*) when no FMC data is available.

Latitude and longitude are displayed in the same order as the FMC POSITION REPORT page. Degree and minute values precede the compass letter, just as the crew uses in a voice report.

② ALTITUDE

Displays the altitude at last sequenced FMC waypoint. Displays all asterisks (*) when no FMC data is available.

③ EST

Displays the next FMC waypoint. Accepts any valid FMC waypoint entry. Requires manual entry for ATC reporting position which is not a route waypoint.

④ NEXT

Displays the next FMC waypoint following EST waypoint. Accepts any valid FMC waypoint entry. Requires manual entry for ATC reporting position which is not a route waypoint.

⑤ SPEED

Displays the current FMC speed. Accepts valid speed entry. Displays all asterisks (*) when no FMC data is available.

⑥ POS FUEL

Displays FMC calculated fuel remaining at the POS waypoint. Displays all asterisks (*) when no FMC data is available.

⑦ ATA

Displays actual time of arrival at the last sequenced FMC waypoint. Displays all asterisks (*) when no FMC data is available.

⑧ ETA

Displays estimated time of arrival for the next FMC waypoint. Accepts valid time entry.

⑨ DEST ETA

Displays estimated time of arrival for the last FMC waypoint. Accepts a valid time entry. Displays all asterisks (*) when no FMC data is available.



⑩ TEMP

Displays current air temperature. Displays all asterisks (*) when no FMC data is available.

⑪ WIND

Displays current wind bearing and speed. Displays all asterisks (*) when no FMC data is available.

Optional Position Report Items

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
POSITION REPORT		
TURBULENCE:		ICING:
◆ LIGHT	◆ TRACE	1
◆ MODERATE	◆ LIGHT	
◆ SEVERE	◆ MODERATE	2
	◆ SEVERE	
		
		
SEND	PRINT	RESET RETURN EXIT

77710029

A report of current turbulence and icing conditions can be included with the POSITION REPORT.

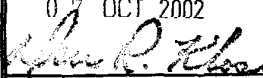
Free Text Message

ATC	FLIGHT INFORMATION	COMPANY		
REVIEW	MANAGER	NEW MESSAGES		
FREE TEXT MESSAGE				
<div>○○○○○○○○○○○○○○○○○○○○○○○○○○○○○○</div> <div>-----</div> <div>-----</div> <div>-----</div> <div>-----</div> <div>-----</div> <div>-----</div> <div>-----</div>				
SEND	PRINT	RESET	RETURN	EXIT

77710030


Nine lines of text can be transmitted.

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		* 42	11/01/02	* 74	11/01/02
* 11	11/01/02	* 43	11/01/02	* 75	11/01/02
* 12	11/01/02	* 44	11/01/02	* 76	11/01/02
* 13	11/01/02	* 45	11/01/02	* 77	11/01/02
* 14	11/01/02	* 46	11/01/02	* 78	11/01/02
* 15	11/01/02	* 47	11/01/02	* 79	11/01/02
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* 19	11/01/02			* 82	11/01/02
* 20	11/01/02	* 51	11/01/02	* 83	11/01/02
		* 52	11/01/02	* 84	11/01/02
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* 22	11/01/02	* 54	11/01/02	FAA APPROVED 07 OCT 2002  DON R. KLOS Principal Operations Inspector	
* 23	11/01/02	* 55	11/01/02		
* 24	11/01/02	* 56	11/01/02		
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* 90	11/01/02	* 121	11/01/02	* 155	11/01/02
		* 122	11/01/02	* 156	11/01/02
* 91	11/01/02	* 123	11/01/02	* 157	11/01/02
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* 97	11/01/02	* 129	11/01/02	* 162	11/01/02
* 98	11/01/02	* 130	11/01/02	* 163	11/01/02
* 99	11/01/02			* 164	11/01/02
* 100	11/01/02	* 131	11/01/02	* 165	11/01/02
		* 132	11/01/02	* 166	11/01/02
* 101	11/01/02	* 133	11/01/02	* 167	11/01/02
* 102	11/01/02	* 134	11/01/02	* 168	11/01/02
* 103	11/01/02	* 135	11/01/02	* 169	11/01/02
* 104	11/01/02	* 136	11/01/02	* 170	11/01/02
* 105	11/01/02	* 137	11/01/02		
* 106	11/01/02	* 138	11/01/02	* 171	11/01/02
* 107	11/01/02	* 139	11/01/02	* 172	11/01/02
* 108	11/01/02	* 140	11/01/02	* 173	11/01/02
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* 110	11/01/02	* 141	11/01/02	* 175	11/01/02
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* 111	11/01/02	* 143	11/01/02	FAA APPROVED 07 OCT 2002  DON R. KLOS Principal Operations Inspector	
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* 114	11/01/02	* 146	11/01/02		
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* 183	11/01/02	* LEP-4	11/01/02		
* 184	11/01/02				
* 185	11/01/02				
* 186	11/01/02				
* 187	Deleted				
* 188	Deleted				
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* 199	Deleted				
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FAA APPROVED

05 OCT 2002

Don R. Klos

DON R. KLOS

Principal Operations Inspector

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INTRODUCTION

The purpose of the Performance Section of the Flight Manual is to provide a convenient source of reference data for use before and during flight operations. Continental Airlines Operations Engineering produces performance data for specific airports/runways, enroute flight, descent, and landing, in accordance with the limitations set by FAR's and Boeing. This data is presented to the flight crew from the Accuload Computer. Information in this section is presented to accomplish the following:

- Supplement data from the Flight Management Computer.
- Provide a source of reference for non-normal operations.

The Performance Section is composed of four main topics:

- Departure Planning: containing conversion tables, windshear V_r speeds and information necessary to confirm takeoff thrust, climb thrust, fuel/time requirements and other pre-departure considerations.
- Enroute: containing information necessary for climb, enroute, descent, holding, approach and diversion flight planning.
- Non-normal: containing information for engine out and other non-normal situations.
- Advisory: containing information for braking distances and other miscellaneous items.

Note: Use caution entering the Departure and Enroute sections. Tables in these sections are similar, however, are computed using different criteria and have different results. Do not use Departure for Enroute data.

DEPARTURE PLANNING

TEMPERATURE CONVERSION CHART

Temp °C - °F

°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
50	122	34	93	18	64	2	36	-14	7
49	120	33	91	17	63	1	34	-15	5
48	118	32	90	16	61	0	32	-16	3
47	117	31	88	15	59	-1	30	-17	1
46	115	30	86	14	57	-2	28	-18	0
45	113	29	84	13	55	-3	27	-19	-2
44	111	28	82	12	54	-4	25	-20	-4
43	109	27	81	11	52	-5	23	-21	-6
42	108	26	79	10	50	-6	21	-22	-8
41	106	25	77	9	48	-7	19	-23	-9
40	104	24	75	8	46	-8	18	-24	-11
39	102	23	73	7	45	-9	16	-25	-13
38	100	22	72	6	43	-10	14	-26	-15
37	99	21	70	5	41	-11	12	-27	-17
36	97	20	68	4	39	-12	10	-28	-18
35	95	19	66	3	37	-13	9	-29	-20

TAT vs. ISA Chart

[illegible]

The Wind Component Chart

The Wind Component Chart provides crosswind and head/tail wind components appropriate to runway heading, wind velocity and direction. To use this chart:

- Determine the angle of wind relative to runway heading,
- Find the wind velocity column (interpolate as necessary), and
- Read the head (H), tail (T), and crosswind (XW) from the intersection of the angle and wind columns (interpolate if required).

WIND COMPONENT CHART

	ANGLE OF WIND RELATIVE TO RUNWAY IN DEGREES									
	WIND VELOCITY AND COMPONENT									
	10 KNOTS		20 KNOTS		30 KNOTS		40 KNOTS		50 KNOTS	
	H/T	XW	H/T	XW	H/T	XW	H/T	XW	H/T	XW
0°	10	0	20	0	30	0	40	0	50	0
10°	9.5	2	19.5	3.5	29.5	5	39.5	7	49	9
20°	9	4	19	7	28	10.5	37.5	14	47	17
30°	8.5	5	17.5	10	26	15	34.5	20	43	25
40°	7	6.5	15.5	13	23	19.5	30.5	26	38.5	32
50°	6	7.5	13	15.5	19.5	23	26	30.5	32	38.5
60°	5	8.5	10	17.5	15	26	20	34.5	25	43
70°	4	9	7	19	10.5	28	14	37.5	17	47
80°	2	9.5	3.5	19.5	5	29.5	7	39.5	9	49
90°	0	10	0	20	0	30	0	40	0	50

TAKEOFF INFORMATION

Takeoff

The maximum allowable takeoff weight will be the least of Field, Climb and Obstacle Limit Weights.

The priority ACCULOAD uses for takeoff flap selection is:

<u>Runway Dry, Damp, Or Wet</u>	<u>Runway Contaminated (Snow, Slush Or Standing Water) Or Ice</u>
1. Flaps 15	1. Flaps 20
2. Flaps 20	2. Flaps 15
3. Flaps 15 Improved	3. Flaps 5
4. Flaps 5	4. Flaps 20 Packs OFF
5. Flaps 5 Improved	5. Flaps 15 Packs OFF
6. Flaps 15 Packs OFF	6. Flaps 5 Packs OFF
7. Flaps 20 Packs OFF	
8. Flaps 15 Improved, Packs OFF	
9. Flaps 5 Packs OFF	
10. Flaps 5 Improved, Packs OFF	

TAKEOFF SPEED CONSIDERATIONS

Takeoff Speeds

FMC computed takeoff speeds can be used for all performance conditions except where adjustments must be made to V_1 for clearway, stopway, brake deactivation, improved climb, contaminated runway situations, unbalanced for brake energy, or obstacle clearance with unbalanced V_1 . These speeds may be used for weights less than or equal to the performance-limited weight.

The FMC will protect for minimum control speeds by increasing V_1 , V_r and V_2 as required. However, the FMC will not compute takeoff speeds for weights where the required speed increase exceeds the maximum certified speed increase. This typically occurs at full rated thrust and light takeoff weights. In this case, the message "V SPEEDS UNAVAILABLE" will appear on the FMC scratchpad and the takeoff speed entries will be blank. Takeoff is not permitted in this condition as certified limits have been exceeded. The options are to select a smaller flap setting, and/or add weight (fuel). Note that the assumed temperature method will not help this condition as the minimum control speeds are determined at the actual temperature and therefore are not reduced.

Takeoff %N₁

The Takeoff %N₁ table contains maximum %N₁ data for a given airport pressure altitude and OAT. The %N₁ Adjustment Table shows %N₁ adjustments for various engine bleed configurations.

TAKEOFF %N₁

Based on engine bleed for packs ON, engine anti-ice ON or OFF, wing anti-ice OFF or AUTO.

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)					
°C	°F	-2000	0	1000	2000	3000	4000
60	140	96.6	96.9	96.9	96.9		
50	122	99.2	99.9	99.9	99.8	99.8	99.9
45	113	100.1	101.4	101.3	101.3	101.4	101.3
40	104	100.9	102.6	102.3	102.5	102.4	102.5
35	95	101.6	103.1	103.1	103.1	103.1	103.2
30	86	101.1	103.6	103.7	103.6	103.6	103.7
25	77	100.2	102.7	103.4	104.0	104.2	104.3
20	68	99.4	101.9	102.5	103.1	103.6	104.1
15	59	98.6	101.0	101.6	102.2	102.7	103.3
10	50	97.7	100.1	100.7	101.3	101.8	102.4
5	41	96.8	99.2	99.8	100.4	100.9	101.4
0	32	96.0	98.3	98.9	99.5	100.0	100.5
-10	14	94.2	96.5	97.1	97.7	98.2	99.7
-20	-4	92.4	94.7	95.2	95.8	96.3	96.8
-30	-22	90.5	92.8	93.3	93.9	94.3	94.8
-40	-40	88.6	90.9	91.4	91.9	92.4	92.9
-50	-58	86.7	88.9	89.4	89.9	90.4	90.9

Based on engine bleed for packs ON, engine anti-ice ON or OFF, wing anti-ice OFF or AUTO.

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)				
°C	°F	5000	6000	7000	8000	9000
60	140					
50	122					
45	113	101.3	101.3	101.3		
40	104	102.6	102.5	102.5	102.0	101.3
35	95	103.1	103.2	103.1	102.7	102.4
30	86	103.7	103.7	103.7	103.3	103.0
25	77	104.5	104.6	104.6	104.2	103.7
20	68	104.8	105.0	105.5	105.3	104.8
15	59	103.9	104.5	105.3	105.6	105.5
10	50	103.0	103.6	104.4	104.8	105.1
5	41	102.1	102.7	103.5	103.9	104.2
0	32	101.1	101.7	102.6	103.0	103.3
-10	14	99.3	99.9	100.7	101.1	101.4
-20	-4	97.4	97.9	98.7	99.1	99.4
-30	-22	95.4	96.0	96.8	97.1	97.4
-40	-40	93.4	94.0	94.8	95.1	95.4
-50	-58	91.4	92.0	92.7	93.1	93.3

%N₁ Adjustment For Engine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FT)					
	-2000	0	1000	2000	3000	4000
PACKS OFF	0.3	0.3	0.3	0.3	0.3	0.4
1 PACK ON	-0.3	-0.3	-0.3	-0.3	-0.3	-0.4
WING ANTI-ICE ON	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3
ALTERNATE MODE EEC	0	0	0	0.1	0.1	0.1

%N₁ Adjustment For Engine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FT)				
	5000	6000	7000	8000	9000
PACKS OFF	0.4	0.4	0.4	0.5	0.5
1 PACK ON	-0.4	-0.4	-0.4	-0.5	-0.5
WING ANTI-ICE ON	-0.3	-0.3	-0.3	-0.3	-0.3
ALTERNATE MODE EEC	0.2	0.3	0.6	0.9	0.9

WINDSHEAR V_r

Windshear procedures are described in detail in Section 3 of the Flight Manual. This table is provided for determination of rotation speed if windshear is reported or windshear conditions exist. The actual Accuload V_r speed must not be modified.

Note: In no case will windshear V_r be > 20 knots over actual V_r .

WINDSHEAR V_r SPEEDS

WEIGHT (1000 LB)	Flaps 5	Flaps 15	Flaps 20
660	170	162	
640	167	159	154
620	164	156	151
600	161	154	149
580	158	151	146
560	155	148	143
540	152	145	140
520	148	141	137
500	145	138	134
480	141	135	131
460	138	132	127
440	134	128	124
420	131	125	120
400	127	121	117
380	123	118	113
360	119	114	110
340	115	110	106
320	111	106	102

 V_r ADJUSTMENTS

TEMP		PRESSURE ALTITUDE					
°C	°F	-2000	0	2000	4000	6000	8000
60	140	4	4	5	6		
50	122	2	3	4	5	6	7
40	104	1	1	3	4	5	6
30	86	0	0	1	2	3	5
20	68	0	0	1	2	3	4
-60	-76	0	0	1	2	2	3

Example: Flap 15 takeoff, sea level, 86°F, actual G/W = 440,000 lbs.

Accuload V speeds: $V_1 = 121$, $V_r = 128$, $V_2 = 139$

Maximum G/W for the runway = 580,000 lbs.

From the table V_r for 580,000 lbs. takeoff = 151

Speeds entered into CDU are 121, 128, 139

Rotate called at 148 knots. (See above Note)

Note: Do not use this section for Enroute Data.

LONG RANGE CRUISE FLIGHT

Long Range Cruise Maximum Operating Altitude

These tables provide the maximum operating altitude in the same manner as the FMC. Maximum altitudes are shown for a given cruise weight and maneuver capability. Note that this table considers both thrust and buffet limits, providing the more limiting of the two. Any data that is thrust limited is denoted by an asterisk and represents only a thrust limited condition in level flight with 300 ft/min residual rate of climb. Flying above these altitudes with sustained banks in excess of approximately 21° may cause the airplane to lose speed and/or altitude.

Note that optimum altitudes shown in the tables result in buffet related maneuver margins of 1.5g (48° bank) or more. The altitudes shown in the table are limited to the maximum certified altitude of 43100 ft.

LONG RANGE CRUISE MAXIMUM OPERATING ALTITUDE MAX CRUISE THRUST

ISA + 10°C And Below

WEIGHT (1000 LB)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET "G" (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
660	30500	-2	34100*	34100*	34100*	33400	32000
640	31200	-3	35000*	35000*	35000*	34100	32700
620	31900	-5	35700*	35700*	35700*	34800	33300
600	32600	-6	36300*	36300*	36300*	35500	34000
580	33300	-8	37000*	37000*	37000*	36200	34700
560	34100	-10	37700*	37700*	37700*	36900	35500
540	34900	-11	38500*	38500*	38500*	37600	36200
520	35600	-13	39200*	39200*	39200*	38400	37000
500	36500	-14	40000*	40000*	40000*	39300	37800
480	37300	-14	40800*	40800*	40800*	40100	38700
460	38200	-14	41600*	41600*	41600*	41000	39600
440	39100	-14	42500	42500	42500	41900	40500
420	40100	-14	43100	43100	43100	42900	41500
400	41100	-14	43100	43100	43100	43100	42500
380	42200	-14	43100	43100	43100	43100	43100
360	43100	-14	43100	43100	43100	43100	43100
340	43100	-14	43100	43100	43100	43100	43100

* Denotes altitude thrust limited in level flight, 100-fpm residual rate of climb.

LONG RANGE CRUISE MAXIMUM OPERATING ALTITUDE MAX CRUISE THRUST

ISA + 15°C

WEIGHT (1000 LB)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET "G" (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
660	30500	4	32300*	32300*	32300*	32300*	31900
640	31200	2	33600*	33600*	33600*	33600*	32700
620	31900	1	34700*	34700*	34700*	34700*	33400
600	32600	-1	35600*	35600*	35600*	35600*	34200
580	33300	-2	36300*	36300*	36300*	36300*	35000
560	34100	-4	37100*	37100*	37100*	37100*	35800
540	34900	-6	38000*	38000*	38000*	38000*	36700
520	35600	-8	38800*	38800*	38800*	38800*	37500
500	36500	-9	39700*	39700*	39700*	39700*	38500
480	37300	-9	40600*	40600*	40600*	40600*	39400
460	38200	-9	41500*	41500*	41500*	41500*	40500
440	39100	-9	42500*	42500*	42500*	42500*	41500
420	40100	-9	43100	43100	43100	43100	42600
400	41100	-9	43100	43100	43100	43100	43100
380	42200	-9	43100	43100	43100	43100	43100
360	43100	-9	43100	43100	43100	43100	43100
340	43100	-9	43100	43100	43100	43100	43100

* Denotes altitude thrust limited in level flight, 100-fpm residual rate of climb.

LONG RANGE CRUISE MAXIMUM OPERATING ALTITUDE MAX CRUISE THRUST

ISA + 20°C

WEIGHT (1000 LB)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET "G" (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
660	30500	10	30600*	30600*	30600*	30600*	30600*
640	31200	8	32200*	32200*	32200*	32200*	32200*
620	31900	7	33500*	33500*	33500*	33500*	33500
600	32600	5	34700*	34700*	34700*	34700*	34000
580	33300	3	35600*	35600*	35600*	35600*	34700
560	34100	2	36200*	36200*	36200*	36200*	35500
540	34900	-0	36900*	36900*	36900*	36900*	36200
520	35600	-2	37700*	37700*	37700*	37700*	37000
500	36500	-3	38500*	38500*	38500*	38500*	37800
480	37300	-3	39300*	39300*	39300*	39300*	38700
460	38200	-3	40200*	40200*	40200*	40200*	39600
440	39100	-3	41000*	41000*	41000*	41000*	40500
420	40100	-3	41900*	41900*	41900*	41900*	41500
400	41100	-3	42800	42800*	42800*	42800*	42500
380	42200	-3	43100	43100	43100	43100	43100
360	43100	-3	43100	43100	43100	43100	43100
340	43100	-3	43100	43100	43100	43100	43100

* Denotes altitude thrust limited in level flight, 100-fpm residual rate of climb.

LONG RANGE CRUISE TOTAL FUEL AND TIME CHARTS

Ground To Air Miles Conversion

This table is used to convert ground distance and enroute wind to an equivalent still air distance for use with the Flight Planning Tables.

Long Range Cruise Total Fuel And Time

These tables are provided to determine the time and fuel required to destination. Data is based on economy climb and descent speeds, and long range cruise with normal engine bleed for air conditioning. Tables are provided for high altitude (long distances) and low altitude (short distances).

To determine total fuel and time for a constant altitude cruise, first enter the Ground to Air Miles Conversion Table to convert ground distance and enroute wind to an equivalent still air distance for use with the Reference Fuel and Time Tables. Next, enter the Reference Fuel and Time Table and the desired altitude and read Reference Fuel and Time Required. Lastly, enter the Fuel Required Adjustment Table with the reference fuel and the planned landing weight to obtain fuel required at the planned landing weight.

LONG RANGE CRUISE TOTAL FUEL AND TIME TABLES

Ground To Air Miles Conversion – High Altitude

AIR DISTANCE (NM)					GROUND DIST. (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
531	499	469	444	421	400	382	366	351	337	325
1056	993	936	886	841	800	766	735	706	679	656
1578	1485	1401	1327	1261	1200	1150	1104	1061	1022	986
2097	1977	1866	1768	1681	1600	1535	1473	1417	1365	1317
2616	2467	2330	2209	2100	2000	1919	1843	1772	1708	1648
3133	2955	2793	2649	2519	2400	2303	2212	2128	2051	1980
3649	3443	3255	3088	2938	2800	2687	2582	2484	2394	2311
4163	3930	3717	3527	3357	3200	3071	2951	2840	2737	2643
4676	4415	4278	3966	3775	3600	3455	3320	3195	3080	2974
5187	4900	4638	4404	4194	4000	3840	3690	3551	3423	3305
5697	5384	5097	4842	4612	4400	4224	4059	3906	3765	3636
6205	5866	5556	5280	5030	4800	4608	4429	4262	4108	3967
6712	6348	6015	5717	5448	5200	4992	4798	4618	4451	4299
7218	6829	6472	6154	5865	5600	5376	5167	4973	4794	4630
7723	7309	6930	6590	6283	6000	5761	5537	5329	5137	4961
8226	7788	7386	7026	6700	6400	6145	5906	5685	5480	5292
8729	8266	7842	7462	7117	6800	6529	6276	6040	5823	5623
9231	8744	8298	7898	7535	7200	6913	6645	6396	6166	2954
9733	9222	8754	8333	7952	7600	7297	7014	6751	6508	6285
10235	9700	9209	8769	8369	8000	7681	7383	7106	6851	6616

LONG RANGE CRUISE TOTAL FUEL AND TIME TABLES

Reference Fuel And Time Required

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	29		31		33		35		37 & ABOVE	
	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)
400	14.3	1:04	14.0	1:03	13.9	1:02	13.8	1:02	13.8	1:01
800	26.2	2:01	25.3	1:58	24.9	1:56	24.6	1:54	24.4	1:51
1200	38.3	2:56	36.9	2:53	36.2	2:49	35.6	2:45	35.1	2:42
1600	50.4	3:52	48.6	3:46	47.6	3:41	46.8	3:36	46.0	3:32
2000	62.6	4:47	60.3	4:40	59.0	4:34	58.0	4:27	57.0	4:22
2400	75.2	5:41	72.5	5:33	70.9	5:25	69.7	5:18	68.4	5:11
2800	87.8	6:35	84.8	6:25	82.9	6:16	81.3	6:08	79.9	6:01
3200	100.7	7:28	97.3	7:17	95.1	7:07	93.3	6:58	91.7	6:51
3600	113.9	8:20	110.0	8:09	107.6	7:57	105.6	7:47	103.8	7:41
4000	127.0	9:13	122.8	9:00	120.2	8:47	117.8	8:37	115.9	8:30
4400	140.8	10:04	136.2	9:50	133.3	9:37	130.7	9:26	128.9	9:20
4800	154.6	10:55	149.6	10:40	146.4	10:26	143.6	10:16	141.8	10:10
5200	168.7	11:46	163.4	11:30	159.8	11:15	156.9	11:05	155.4	11:00
5600	183.1	12:36	177.4	12:19	173.6	12:04	170.6	11:55	169.5	11:50
6000	197.5	13:26	191.5	13:09	187.6	12:53	184.3	12:45	183.7	12:40
6400	212.6	14:15	206.2	13:57	202.0	13:43	199.2	13:34		
6800	227.7	15:04	221.0	14:46	216.5	14:32	214.0	14:24		
7200	243.2	15:53	236.2	15:35	231.6	15:21	229.6	15:14		
7600	259.0	16:42	251.7	16:23	247.2	16:10	246.0	16:04		
8000	274.9	17:31	267.3	17:12	262.9	16:59	262.4	16:54		

Fuel Required Adjustment (1000 LB)

REFERENCE FUEL REQUIRED (1000 LB)	FUEL REQUIRED ADJUSTMENTS (1000 LB)				
	LANDING WEIGHT (1000 LB)				
	300	400	500	600	700
20	-2.9	-1.4	0.0	1.7	3.6
40	-5.4	-2.5	0.0	3.5	8.1
60	-7.9	-3.7	0.0	5.6	13.2
80	-10.5	-5.0	0.0	8.1	19.1
100	-13.1	-6.3	0.0	10.9	25.6
120	-15.9	-7.6	0.0	14.1	32.8
140	-18.6	-9.0	0.0	17.6	40.6
160	-21.4	-10.5	0.0	21.5	49.2
180	-24.3	-12.0	0.0	25.7	58.4
200	-27.3	-13.5	0.0	30.2	68.2
220	-30.2	-15.2	0.0	35.1	78.8
240	-33.3	-16.8	0.0	40.3	90.0
260	-36.4	-18.5	0.0	45.9	101.9
280	-39.6	-20.3	0.0	51.9	114.5

Based on 310/.84 climb, Long Range Cruise and .84/310 descent.

- Notes:
1. Taxi fuel 75 lb/min.
 2. APU on ground 530 lb/hr.
 3. APU in air 200 lb/hr.

Long Range Cruise Step Fuel And Time

The Long Range Cruise Step Total Fuel and Time Tables are provided to determine trip time and fuel required to destination when flying a step climb profile. Step climb profiles are based on 4000 ft. step climbs to keep the flight within 2000 ft. of the optimum altitude for the current cruise weight. To determine trip fuel and time, enter the Ground to Air Miles Conversion Table and determine air distance as discussed above. Then enter the trip fuel and time required with air distance and planned landing weight to read trip fuel. Continue across the table to read trip home.

LONG RANGE CRUISE STEP CLIMB FUEL AND TIME

Ground To Air Miles Conversion

AIR DISTANCE (NM)					GROUND DIST. (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
1042	982	929	882	839	800	765	732	702	675	649
1547	1462	1387	1318	1256	1200	1148	1101	1058	1017	980
2052	1942	1844	1755	1674	1600	1532	1470	1413	1360	1311
2557	2422	2301	2191	2091	2000	1917	1840	1769	1703	1642
3062	2902	2758	2627	2508	2400	2301	2209	2125	2046	1974
3566	3381	3214	3063	2926	2800	2685	2578	2480	2389	2305
4070	3860	3671	3499	3343	3200	3069	2948	2836	2733	2636
4574	4339	4127	3935	3760	3600	3453	3317	3192	3076	2968
5078	4818	4584	4371	4177	4000	3837	3687	3548	3419	3299
5582	5297	5040	4807	4595	4400	4221	4056	3904	3763	3631
6085	5776	5497	5243	5012	4800	4605	4426	4260	4106	3963
6589	6255	5953	5679	5429	5200	4990	4796	4616	4450	4295
7093	6734	6409	6115	5846	5600	5374	5165	4972	4793	4626
7596	7212	6866	6551	6263	6000	5758	5535	5328	5137	4958
8099	7691	7322	6986	6680	6400	6142	5904	5684	5480	5290
8606	8170	7778	7422	7097	6800	6526	6274	6040	5824	5622
9107	8649	8234	7858	7515	7200	6911	6644	6396	6167	5954
9610	9127	8691	8294	7932	7600	7295	7013	6753	6511	6285
10114	9606	9147	8730	8369	8000	7679	7383	7109	6854	6617

LONG RANGE CRUISE STEP CLIMB FUEL AND TIME

Step Climb Total Fuel And Time Required

AIR DIST (NM)	TRIP FUEL (1000 LB)					TIME (H:M)
	LANDING WEIGHT (1000 LB)					
	300	350	400	450	500	
800	20.4	22.2	24.5	26.9	29.3	1:51
1200	29.2	31.6	35.1	38.5	42.4	2:41
1600	38.0	41.2	46.0	50.5	55.8	3:31
2000	47.0	51.0	57.1	62.8	69.4	4:21
2400	55.9	61.0	68.4	75.4	83.3	5:11
2800	65.0	71.2	79.9	88.3	97.5	6:01
3200	74.3	81.8	91.7	101.6	112.1	6:50
3600	83.8	92.5	103.7	115.1	127.1	7:40
4000	93.4	103.6	116.1	129.0	142.4	8:30
4400	103.2	114.8	128.8	143.1	158.0	9:19
4800	113.3	126.2	141.8	157.5	174.0	10:08
5200	123.6	137.9	155.1	172.3	190.3	10:58
5600	134.2	149.9	168.8	187.5	207.0	11:47
6000	145.0	162.1	182.7	203.1	224.1	12:36
6400	156.0	174.8	196.9	217.0	241.6	13:26
6800	167.3	187.7	211.4	235.2	259.6	14:15
7200	178.9	200.9	226.3	251.9	278.2	15:04
7600	190.6	214.4	241.6	268.8	297.3	15:54
8000	202.6	228.3	257.3	286.2	317.0	16:43

Based on 310/.84 climb, LRC, and .84/310/250 descent.

Valid for all pressure altitudes with 4000 ft. step climb to 2000 ft. above optimum altitude.

SHORT RANGE TOTAL FUEL AND TIME

These tables are provided to determine trip fuel and time for short distances or alternates. The data considers the use of the FMC short trip optimum altitude.

Obtain air distance from upper table using the ground distance and wind component to the alternate. Enter lower table with air distance and read trip fuel required for the expected landing weight, together with time to alternate at right. For distances greater than shown or other altitudes, use the Long Range Cruise Total Fuel and Time Tables.

SHORT RANGE TOTAL FUEL AND TIME**Ground To Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DIST. (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
89	77	68	61	55	50	46	43	40	37	35
157	141	128	117	108	100	93	87	82	78	73
222	203	186	172	160	150	141	133	126	119	113
286	263	244	227	213	200	189	179	169	161	154
348	323	301	282	265	250	237	225	214	204	195
410	382	358	336	317	300	285	271	258	247	237
471	441	414	390	369	350	333	317	303	290	278
533	500	470	444	421	400	381	364	348	333	320
596	560	527	499	473	450	429	410	392	376	362
660	620	585	554	525	500	477	456	437	419	402

Short Trip Total Fuel And Time Required

AIR DIST. (NM)		TRIP FUEL (1000 LB)					TIME (H:M)
		LANDING WEIGHT (1000 LB)					
		300	350	400	450	500	
50	Fuel (1000 lb)	2.9	3.1	3.4	3.6	3.9	0:13
	Alt (ft)	9000	9000	9000	7000	7000	
100	Fuel (1000 lb)	4.5	4.8	5.2	5.5	5.9	0:22
	Alt (ft)	15000	15000	15000	13000	13000	
150	Fuel (1000 lb)	6.0	6.5	6.9	7.4	7.9	0:29
	Alt (ft)	23000	21000	21000	21000	21000	
200	Fuel (1000 lb)	7.3	7.9	8.5	9.1	9.7	0:36
	Alt (ft)	29000	27000	27000	27000	25000	
250	Fuel (1000 lb)	8.5	9.2	10.0	10.7	11.4	0:42
	Alt (ft)	35000	31000	31000	29000	27000	
300	Fuel (1000 lb)	9.6	10.5	11.3	12.2	13.1	0:48
	Alt (ft)	39000	35000	33000	31000	29000	
350	Fuel (1000 lb)	10.7	11.7	12.7	13.7	14.7	0:54
	Alt (ft)	41000	37000	37000	35000	31000	
400	Fuel (1000 lb)	11.8	12.8	14.0	15.1	16.3	1:00
	Alt (ft)	41000	41000	39000	37000	35000	
450	Fuel (1000 lb)	12.8	13.9	15.2	16.5	17.9	1:06
	Alt (ft)	41000	41000	39000	37000	35000	
500	Fuel (1000 lb)	13.9	15.1	16.5	17.9	19.4	1:13
	Alt (ft)	41000	41000	39000	37000	35000	

LANDING LIMIT EXPLANATIONS**Landing**

Tables are provided for determining the maximum landing weight as limited by field length or climb requirements for flaps 30.

Maximum landing weight is the lessor of the field length limit weight and climb limit weight; do not exceed maximum structural landing weight.

Landing Field Limit Weight

Obtain wind corrected field length by entering upper table with field length available and wind component along the runway. Now enter lower table with wind corrected field length and pressure altitude to read field limit weight for the expected runway condition.

Landing Climb Limit Weight

Enter table with airport OAT and pressure altitude to read landing climb limit weight. Apply the noted adjustments as required.

LANDING FIELD LIMIT WEIGHT

Flaps 30

Wind Corrected Field Length (FT)

FIELD LENGTH AVAILABLE (FT)	WIND COMPONENT (KTS)						
	-15	-10	0	10	20	30	40
3950	2850	3175	3950	4200	4475	4750	5025
4275	3125	3475	4275	4550	4825	5100	5400
4600	3400	3775	4600	4875	5150	5475	5750
4925	3700	4075	4925	5225	5500	5825	6125
5250	3975	4375	5250	5550	5850	6175	6500
5575	4250	4675	5575	5900	6200	6525	6850
5900	4550	5000	5900	6225	6550	6900	7250
6250	4825	5275	6250	6550	6900	7250	7625
6575	5100	5575	6575	6900	7250	7625	8025
6900	5400	5875	6900	7250	7600	8000	8400
7225	5700	6150	7225	7600	7950	8375	8775
7550	5950	6450	7550	7925	8300	8725	9150
7875	6250	6725	7875	8250	8650	9125	9600
8200	6525	7025	8200	8600	9000	9550	10075
8525	6775	7325	8525	8950	9375	10000	10600
8875	7050	7600	8875	9325	9800	10475	11125
9200	7300	7900	9200	9725	10250	10950	11650
9525	7525	8150	9525	10125	10750	11450	12175

Field Limit Weight (1000 LB)

WIND CORR'D FIELD LENGTH (FT)	AIRPORT PRESSURE ALTITUDE (FT)							
	0		1000		2000		3000	
	DRY	WET	DRY	WET	DRY	WET	DRY	WET
3950	313.1	260.1	304.2	251.3	293.2	242.5	284.4	233.7
4275	348.3	288.8	337.3	280.0	328.5	271.2	317.5	262.3
4600	383.6	317.5	372.6	308.6	361.6	299.8	350.5	291.0
4925	421.1	350.5	410.1	339.5	396.8	328.5	385.8	319.7
5250	458.6	381.4	445.3	370.4	432.1	359.3	418.9	348.3
5575	491.6	414.5	480.6	401.2	467.4	390.2	454.1	377.0
5900	513.7	445.3	504.9	432.1	496.0	418.9	487.2	407.9
6250	535.7	478.4	526.9	465.2	515.9	449.7	507.1	436.5
6575	555.6	500.4	546.7	491.6	535.7	480.6	526.9	467.4
6900	575.4	520.3	566.6	511.5	555.6	502.6	546.7	491.6
7225	595.2	537.9	586.4	529.1	575.4	520.3	564.4	509.3
7550	615.1	555.6	604.1	546.7	593.0	535.7	584.2	526.9
7875	632.7	573.2	621.7	564.4	612.9	553.4	601.9	544.5
8200	650.4	590.8	641.5	579.8	630.5	571.0	619.5	560.0
8525	668.0	606.3	657.0	597.4	645.9	586.4	634.9	577.6
8875	685.6	623.9	674.6	612.9	663.6	601.9	652.6	593.0
9200	703.3	639.3	692.2	628.3	679.0	617.3	668.0	608.5
9525	720.9	654.8	709.9	643.7	696.7	632.7	685.6	621.7

Decrease field limit weight 23150 lbs. for each deactivated brake.

Decrease field limit weight 48500 lbs. when using manual speed brakes.

LANDING CLIMB LIMIT WEIGHT

Valid for approach with flaps 20 and landing with flaps 25 or 30.

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)			
°C	°F	0	1000	2000	3000
54	129	506.8			
52	126	519.2	499.8		
50	122	531.8	512.1	492.3	
48	118	545.0	524.6	504.6	485.1
46	115	558.3	537.6	517.1	497.4
44	111	572.1	550.8	530.0	509.8
42	108	586.8	564.3	542.9	522.4
40	104	602.2	578.3	556.1	535.3
38	100	617.3	593.2	569.8	548.7
36	97	630.6	605.8	582.6	560.0
34	93	643.8	618.0	595.2	571.1
32	90	653.5	629.1	604.4	580.6
30	86	663.4	638.8	613.7	589.3
28	82	663.8	648.1	623.1	597.9
26	79	664.3	648.5	632.5	606.2
24	75	664.8	649.0	632.9	613.9
22	72	665.2	649.4	633.3	614.4
20	68	665.6	649.8	633.7	614.7
18	64	666.1	650.2	634.1	615.0
16	61	666.5	650.6	634.5	615.3
14	57	666.9	650.9	634.8	615.6
12	54	667.4	651.3	635.1	615.9
10	50	667.8	651.8	635.5	616.2
-40	-40	670.2	654.1	637.7	618.2

Based on engine bleed for 2 packs on and engine anti-ice on or off and wing anti-ice off.

With engine bleed for packs off, increase weight by 6100 lbs.

With engine and wing anti-ice on, decrease weight by 4700 lbs.

When operating in icing conditions during any part of the flight with forecast landing temperature below 10°C, decrease weight by 43200 lbs.

Quick Turnaround Limit Weight

Enter table with airport pressure altitude and OAT to read maximum quick turnaround weight. Apply the noted adjustments as required.

If the landing weight exceeds the maximum quick turnaround weight, wait the specified time and then check that the wheel thermal plugs have not melted before executing a subsequent takeoff.

QUICK TURNAROUND LIMIT WEIGHT

Flaps 30

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)				
°C	°F	0	2000	4000	6000	8000
54	129	514.5				
50	122	517.9	498.3			
45	113	522.3	502.5	483.2		
40	104	526.8	506.8	487.2	468.7	
35	95	531.4	511.2	491.5	472.6	454.2
30	86	536.1	515.8	495.8	476.6	458.1
25	77	540.9	520.4	500.3	480.7	462.0
20	68	545.9	525.2	504.9	484.8	466.0
15	59	551.0	530.1	509.6	489.3	470.2
10	50	556.2	535.1	514.4	494.0	474.4
5	41	561.6	540.3	519.4	498.7	478.8
0	32	567.2	545.6	524.5	503.6	483.3
-5	23	572.9	551.1	529.7	508.7	488.0
-10	14	578.8	556.8	535.1	513.9	493.0
-15	5	584.8	562.6	540.7	519.2	498.2
-20	-4	591.0	568.6	546.5	524.8	503.5
-30	-22	603.9	581.2	558.6	536.3	514.5
-40	-40	617.2	594.4	571.4	548.7	526.3
-50	-58	630.5	607.5	584.9	561.8	538.7
-54	-65	636.0	612.8	590.0	567.1	543.7

Increase weight by 5500 lbs. per 1% uphill slope. Decrease weight by 9000 lbs. per 1% downhill slope.

Increase weight by 14300 lbs. per 10 knots headwind. Decrease weight by 64000 lbs. per 10 knots tailwind.

Decrease weight by 26000 lbs. when one brake is deactivated. Decrease weight by 53400 lbs. when two brakes are deactivated.

After landing at weights exceeding those shown above, adjusted for slope and wind, wait at least 65 minutes and check that wheel thermal plugs have not melted before executing a takeoff.

As an alternate procedure, no waiting period is required if the **BRAKE TEMP** advisory message on EICAS is not displayed 10 to 15 minutes after parking.

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ENROUTE

MAX CLIMB POWER SETTING

This table shows Max Climb %N₁ for a 310 KIAS/.84M climb speed schedule, normal engine bleed for packs ON and anti-ice OFF. Enter the table with airport pressure altitude and TAT and read %N₁. %N₁ adjustments are shown for anti-ice operation.

MAX CLIMB %N₁

Based on engine bleed for packs ON or OFF and anti-ice OFF

TAT		PRESSURE ALTITUDE (FT) AND SPEED IAS (MACH)									
		0	5000	10000	15000	20000	25000	30000	35000	40000	43000
°C	°F	310 .47	310 .51	310 .56	310 .61	310 .67	310 .74	310 .81	287 .84	256 .84	239 .84
60	140	88.7	88.6	90.3	92.6	95.3	98.0	101.3	105.1	105.1	103.8
50	122	90.4	90.1	90.1	91.2	93.9	96.5	99.8	103.6	103.5	102.2
40	104	92.4	92.3	92.3	92.3	92.7	95.0	98.2	101.9	101.9	100.7
30	86	91.5	94.2	94.2	94.2	94.4	95.2	96.8	100.3	100.2	99.0
20	68	90.0	92.6	95.2	96.0	96.4	96.8	98.1	99.0	98.6	97.4
15	59	89.2	91.8	94.4	96.8	97.0	97.4	98.5	99.5	99.0	98.6
10	50	88.4	91.0	93.5	95.9	97.5	97.9	99.0	99.8	99.5	99.2
5	41	87.6	90.2	92.7	95.1	97.0	98.3	99.3	100.3	99.8	99.6
0	32	86.9	89.4	91.9	94.2	96.1	98.0	99.8	100.9	100.3	100.0
-5	23	86.1	88.6	91.0	93.3	95.2	97.1	99.8	101.7	101.0	100.6
-10	14	85.3	87.7	90.2	92.5	94.3	96.2	98.8	102.9	101.9	101.4
-15	5	84.4	86.9	89.3	91.6	93.4	95.3	97.9	102.8	102.8	102.2
-20	-4	83.6	86.1	88.4	90.7	92.5	94.4	96.9	101.8	101.8	101.3
-25	-13	82.8	85.2	87.6	89.8	91.6	93.4	96.0	100.8	100.8	100.2
-30	-22	81.9	84.3	86.7	88.9	90.7	92.5	95.0	99.8	99.8	99.2
-35	-31	81.1	83.5	85.8	88.0	89.7	91.5	94.0	98.8	98.8	98.2
-40	-40	80.2	82.6	84.9	87.0	88.8	90.6	93.0	97.7	97.7	97.2

%N₁ Adjustments for Engine Bleed

Bleed Configuration	Airport Pressure Altitude (FT)					
	0	10000	20000	30000	40000	43000
2 Packs ON – 1 Bleed Source	-0.3	-0.5	-0.4	-0.3	-0.3	-0.3
1 Pack ON – 1 or 2 Bleed Sources	-0.3	-0.5	-0.4	-0.3	-0.3	-0.3
Engine Anti-ice ON (1,3)	-0.2	-0.3	-0.2	-0.2	-0.2	-0.2
Engine Anti-ice ON (2)	-0.5	-0.8	-0.6	-0.5	-0.5	-0.5
Engine and Wing Anti-ice ON (1)	-0.2	-0.4	-0.3	-0.3	-0.3	-0.3
Engine and Wing Anti-ice ON (2)	-0.5	-0.9	-0.7	-0.6	-0.6	-0.6
Engine and Wing Anti-ice ON (3)	-0.2	-0.5	-0.4	-0.4	-0.4	-0.4

- 2 Packs ON or OFF with 2 bleed sources.
- 2 Packs ON with 1 bleed source or 1 pack ON with 1 or 2 bleed sources.
- Packs OFF with 1 bleed source.

Max Climb Power Time, Fuel, Distance Tables

These tables show the time, fuel and distance to level off using max climb power. The tables assume a 250/310/.84M climb schedule. Enter the correct ISA table and brake release weight for the desired pressure altitude.

MAX CLIMB TIME, FUEL AND DISTANCE

Based on 250/310/.84M, full climb power, zero wind.

ISA + 10°C

PRESSURE ALTITUDE (1000 FT)		BRAKE RELEASE WEIGHT (1000 LB)						
		320	380	440	500	560	620	660
430	TIME (MIN)	15	19					
	FUEL (LB)	7200	9000					
	DIST (NM)	102	132					
410	TIME (MIN)	14	17	22				
	FUEL (LB)	6800	8500	10600				
	DIST (NM)	91	115	148				
390	TIME (MIN)	13	16	20	25			
	FUEL (LB)	6400	8000	9800	12100			
	DIST (NM)	82	103	128	163			
370	TIME (MIN)	12	15	18	22	30		
	FUEL (LB)	6100	7600	9200	11200	14900		
	DIST (NM)	74	92	114	142	198		
350	TIME (MIN)	11	14	17	20	26	31	
	FUEL (LB)	5800	7200	8800	10600	13600	15600	
	DIST (NM)	68	84	104	127	169	200	
330	TIME (MIN)	10	13	16	19	24	28	32
	FUEL (LB)	5600	6900	8300	10000	12700	14400	16600
	DIST (NM)	62	77	95	116	151	175	208
310	TIME (MIN)	10	12	14	17	22	25	29
	FUEL (LB)	5300	6500	7900	9400	11900	13400	15200
	DIST (NM)	57	70	85	104	134	154	179
290	TIME (MIN)	9	11	13	16	20	22	25
	FUEL (LB)	4900	6000	7300	8700	10900	12200	13700
	DIST (NM)	50	61	74	90	115	131	151
270	TIME (MIN)	8	10	12	14	17	20	22
	FUEL (LB)	4600	5600	6700	8000	9500	11100	12500
	DIST (NM)	43	53	65	78	93	112	128
250	TIME (MIN)	7	9	11	13	15	18	20
	FUEL (LB)	4300	5200	6200	7400	8700	10200	11300
	DIST (NM)	38	46	56	67	80	96	108
230	TIME (MIN)	7	8	10	11	14	16	18
	FUEL (LB)	3900	4800	5800	6800	8000	9300	10300
	DIST (NM)	33	40	48	58	69	82	92
210	TIME (MIN)	6	7	9	10	12	14	16
	FUEL (LB)	3600	4400	5300	6300	7300	8500	9400
	DIST (NM)	28	34	41	49	58	69	78
180	TIME (MIN)	5	6	7	9	10	12	13
	FUEL (LB)	3200	3900	4700	5500	6400	7400	8100
	DIST (NM)	22	27	32	39	45	54	60
100	TIME (MIN)	3	3	4	5	5	6	7
	FUEL (LB)	1900	2300	2700	3200	3700	4200	4500
	DIST (NM)	7	9	11	13	15	18	20

CLIMB TIME, FUEL AND DISTANCE

Based on 250/310/.84M, full climb power, zero wind.

ISA

PRESSURE ALTITUDE (1000 FT)		BRAKE RELEASE WEIGHT (1000 LB)						
		320	380	440	500	560	620	660
430	TIME (MIN)	15	19					
	FUEL (LB)	6800	8600					
	DIST (NM)	97	126					
410	TIME (MIN)	14	17	21				
	FUEL (LB)	6500	8100	10100				
	DIST (NM)	86	110	141				
390	TIME (MIN)	12	15	19	24			
	FUEL (LB)	6200	7700	9400	11600			
	DIST (NM)	78	98	122	155			
370	TIME (MIN)	12	14	17	21	27		
	FUEL (LB)	5900	7300	8800	10700	13100		
	DIST (NM)	71	88	109	135	171		
350	TIME (MIN)	11	13	16	20	24	30	
	FUEL (LB)	5600	6900	8400	10100	12200	14900	
	DIST (NM)	65	80	99	121	149	190	
330	TIME (MIN)	10	13	15	18	22	27	31
	FUEL (LB)	5400	6600	8000	9600	11500	13800	15900
	DIST (NM)	60	74	90	110	134	167	197
310	TIME (MIN)	9	12	14	17	20	24	28
	FUEL (LB)	5100	6200	7500	9000	10700	12800	14500
	DIST (NM)	54	67	81	99	120	147	171
290	TIME (MIN)	9	11	13	15	18	22	25
	FUEL (LB)	4700	5800	7000	8300	9900	11700	13200
	DIST (NM)	47	58	71	86	103	125	144
270	TIME (MIN)	8	10	12	14	16	19	22
	FUEL (LB)	4400	5400	6500	7700	9100	10700	12000
	DIST (NM)	41	51	62	74	89	107	122
250	TIME (MIN)	7	9	11	12	15	17	19
	FUEL (LB)	4100	5000	6000	7100	8400	9800	10900
	DIST (NM)	36	44	54	64	76	91	112
230	TIME (MIN)	7	8	10	11	13	15	17
	FUEL (LB)	3800	4600	5600	6600	7700	9000	9900
	DIST (NM)	31	38	46	55	66	78	88
210	TIME (MIN)	6	7	9	10	12	14	15
	FUEL (LB)	3500	4300	5100	6100	7100	8200	9000
	DIST (NM)	27	33	40	47	56	66	74
180	TIME (MIN)	5	6	7	9	10	12	13
	FUEL (LB)	3100	3800	4500	5300	6200	7100	7800
	DIST (NM)	21	26	31	37	43	51	57
100	TIME (MIN)	3	3	4	5	5	6	7
	FUEL (LB)	1800	2200	2700	3100	3600	4100	4400
	DIST (NM)	7	9	10	12	15	17	19

CLIMB TIME, FUEL AND DISTANCE

Based on 250/310/.84M, full climb power, zero wind.

ISA -10°C

PRESSURE ALTITUDE (1000 FT)		BRAKE RELEASE WEIGHT (1000 LB)						
		320	380	440	500	560	620	660
430	TIME (MIN)	14	18					
	FUEL (LB)	6500	8200					
	DIST (NM)	92	119					
410	TIME (MIN)	13	17	21				
	FUEL (LB)	6200	7700	9600				
	DIST (NM)	82	104	133				
390	TIME (MIN)	12	15	19	23			
	FUEL (LB)	5900	7300	9000	11000			
	DIST (NM)	74	93	116	148			
370	TIME (MIN)	11	14	17	21	26		
	FUEL (LB)	5600	6900	8500	10200	12500		
	DIST (NM)	67	84	104	128	162		
350	TIME (MIN)	11	13	16	19	23	29	
	FUEL (LB)	5400	6600	8000	9700	11600	14200	
	DIST (NM)	62	76	94	115	142	180	
330	TIME (MIN)	10	12	15	18	21	26	30
	FUEL (LB)	5100	6300	7600	9200	11000	13200	15100
	DIST (NM)	57	70	86	105	128	158	187
310	TIME (MIN)	9	11	14	17	20	24	27
	FUEL (LB)	4900	6000	7200	8600	10300	12200	13900
	DIST (NM)	51	64	78	94	114	139	162
290	TIME (MIN)	8	10	12	15	18	21	24
	FUEL (LB)	4500	5600	6700	8000	9500	11200	12600
	DIST (NM)	45	56	68	82	98	119	137
270	TIME (MIN)	8	9	11	14	16	19	21
	FUEL (LB)	4200	5200	6200	7400	8700	10300	11500
	DIST (NM)	40	49	59	71	85	102	116
250	TIME (MIN)	7	9	10	12	14	17	19
	FUEL (LB)	3900	4800	5800	6900	8100	9400	10400
	DIST (NM)	35	42	51	61	73	87	99
230	TIME (MIN)	6	8	9	11	13	15	17
	FUEL (LB)	3700	4500	5400	6300	7400	8600	9500
	DIST (NM)	30	37	44	53	63	74	84
210	TIME (MIN)	6	7	8	10	12	13	15
	FUEL (LB)	3400	4100	4900	5800	6800	7900	8700
	DIST (NM)	26	32	38	45	53	63	71
180	TIME (MIN)	5	6	7	8	10	11	12
	FUEL (LB)	3000	3700	4400	5100	6000	6900	7500
	DIST (NM)	20	25	30	35	42	49	55
100	TIME (MIN)	3	3	4	5	5	6	6
	FUEL (LB)	1800	2200	2600	3000	3500	4000	4300
	DIST (NM)	7	8	10	12	14	16	18

Long Range Cruise Control

These tables provide target %N₁, LRC Mach number, IAS and standard day fuel flow per engine for the airplane weight and pressure altitude. As indicated by the shaded area, at optimum altitude .84 Mach approximates the LRC Mach schedule.

ENROUTE LONG RANGE CRUISE TABLES

Note: Do not use this section for dispatch performance.

Long Range Cruise Control

WEIGHT (1000 LB)		PRESSURE ALTITUDE (1000 FT)									
		25	27	29	31	33	35	37	39	41	43
660	%N ₁	87.8	89.4	91.0	92.5	94.7					
	Mach	.772	.802	.834	.843	.839					
	KIAS	325	325	325	315	300					
	FF/ENG	9561	9643	9787	9845	9993					
620	%N ₁	86.7	88.3	89.9	91.1	92.6	95.4				
	Mach	.772	.802	.834	.844	.842	.837				
	KIAS	325	325	325	315	301	286				
	FF/ENG	9190	9233	9363	9264	9201	9501				
580	%N ₁	85.2	86.9	88.5	89.7	91.0	92.7	96.8			
	Mach	.764	.791	.817	.839	.844	.841	.834			
	KIAS	321	320	318	313	302	288	272			
	FF/ENG	8728	8694	8716	8703	8570	8597	9101			
540	%N ₁	83.4	85.1	86.7	88.2	89.5	90.8	93.2			
	Mach	.742	.769	.796	.823	.841	.843	.840			
	KIAS	312	310	309	307	301	288	274			
	FF/ENG	8098	8049	8040	8077	8050	7924	8032			
500	%N ₁	81.4	83.1	84.8	86.4	87.9	89.2	90.9	94.1		
	Mach	.720	.746	.773	.801	.827	.843	.843	.839		
	KIAS	301	300	299	298	295	288	275	261		
	FF/ENG	7483	7426	7396	7410	7458	7403	7323	7558		
460	%N ₁	79.2	81.0	82.7	84.4	86.1	87.5	89.2	91.4	94.7	
	Mach	.694	.721	.747	.775	.803	.830	.843	.843	.838	
	KIAS	290	290	288	287	286	283	275	263	249	
	FF/ENG	7001	6976	6781	6773	6811	6836	6789	6789	7079	
420	%N ₁	76.9	78.6	80.4	82.1	83.9	85.5	87.4	89.4	91.7	95.1
	Mach	.665	.665	.721	.747	.776	.804	.831	.843	.843	.837
	KIAS	277	277	277	276	275	274	271	263	251	238
	FF/ENG	6362	6352	6329	6161	6168	6206	6243	6247	6259	6551
380	%N ₁	74.6	76.1	77.9	79.6	81.4	83.1	85.1	87.5	89.5	91.7
	Mach	.639	.662	.690	.718	.745	.774	.803	.830	.843	.843
	KIAS	266	264	264	264	263	262	261	258	251	240
	FF/ENG	5787	5726	5710	5574	5545	5558	5624	5723	5712	5718
340	%N ₁	72.0	73.6	75.1	76.8	78.6	80.4	82.5	85.0	87.3	89.3
	Mach	.611	.633	.656	.683	.712	.740	.769	.799	.826	.843
	KIAS	253	252	251	250	251	250	249	247	245	239
	FF/ENG	5209	5159	5097	4964	4962	4949	5001	5099	5173	5281
300	%N ₁	69.0	70.7	72.3	73.8	75.5	77.3	79.4	81.9	84.5	86.8
	Mach	.579	.601	.624	.647	.673	.703	.732	.760	.790	.818
	KIAS	239	238	238	236	236	236	235	234	233	232
	FF/ENG	4620	4581	4535	4489	4469	4466	4510	4564	4647	4717

Shaded area approximates optimum altitude.

Long Range Cruise Enroute Fuel And Time

Long Range Cruise Enroute Fuel and Time Tables are provided to determine remaining time and fuel required to destination. The data is based on LRC cruise and .84/310/250 descent. Tables are presented for low altitudes for shorter trip distances and high altitudes for longer trip distances.

To determine remaining fuel and time required first enter the Ground to Air Miles Conversion table to convert ground distance and enroute wind to an equivalent still air distance for use with the Reference Fuel and Time tables. Next, enter the Reference Fuel and Time table with the converted and the desired altitude and read Reference Fuel and Time Required. Lastly, enter the Fuel Required Adjustment table with the Reference fuel and the actual weight at checkpoint to obtain fuel required to destination.

LONG RANGE CRUISE ENROUTE FUEL AND TIME – LOW ALTITUDE Ground To Air Miles Conversion

AIR DISTANCE (NM)					GROUND DIST. (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
281	260	241	226	212	200	191	182	174	167	161
561	520	484	452	425	400	382	366	351	337	325
842	780	725	678	637	600	574	549	527	507	488
1124	1041	968	904	850	800	765	733	704	676	652
1407	1304	1211	1132	1062	1000	957	917	880	846	815
1691	1566	1454	1358	1275	1200	1148	1100	1055	1015	978
1975	1828	1697	1586	1488	1400	1340	1284	1232	1184	1140
2261	2092	1941	1813	1701	1600	1531	1466	1407	1352	1303
2548	2357	2186	2041	1914	1800	1722	1649	1582	1521	1465
2835	2622	2431	2269	2127	2000	1913	1833	1759	1690	1628

LONG RANGE CRUISE ENROUTE FUEL AND TIME – LOW ALTITUDE Fuel And Time Required

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		20		24		28	
	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)
200	8.1	0:38	7.0	0:37	5.8	0:35	5.2	0:34	4.5	0:33
400	17.0	1:12	15.3	1:09	13.4	1:05	12.3	1:02	11.0	1:00
600	25.8	1:47	23.5	1:42	20.8	1:35	19.3	1:31	17.6	1:27
800	34.6	2:22	31.6	2:15	28.2	2:06	26.3	1:59	24.1	1:54
1000	43.3	2:57	39.6	2:48	35.5	2:36	33.2	2:28	30.6	2:21
1200	51.8	3:32	47.6	3:22	42.8	3:07	40.1	2:57	37.1	2:48
1400	60.4	4:08	55.5	3:55	50.0	3:38	46.9	3:27	43.5	3:16
1600	68.8	4:44	63.4	4:30	57.1	4:09	53.6	3:56	49.8	3:34
1800	77.1	5:20	71.1	5:04	64.2	4:41	60.3	4:26	56.1	4:11
2000	85.4	5:57	78.8	5:38	71.2	5:12	67.0	4:5	62.3	4:39

Fuel Required Adjustment (1000)

REFERENCE FUEL REQUIRED (1000 LB)	WEIGHT AT CHECKPOINT (1000 LB)				
	300	400	500	600	700
5	-0.4	-0.1	0.0	0.4	0.8
10	-1.6	-0.7	0.0	1.0	2.1
15	-2.9	-1.3	0.0	1.6	3.3
20	-3.9	-1.9	0.0	2.2	4.6
25	-5.0	-2.5	0.0	2.7	5.8
30	-6.1	-3.0	0.0	3.3	7.1
35	-7.1	-3.5	0.0	3.9	8.3
40	-8.2	-4.0	0.0	4.4	9.5

Based on LRC and .84/310/250 descent.

LONG RANGE CRUISE ENROUTE FUEL AND TIME – HIGH ALTITUDE
Ground To Air Miles Conversion

AIR DISTANCE (NM)					GROUND DIST. (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
522	492	466	441	420	400	383	367	353	340	328
1036	979	927	881	839	800	767	737	709	683	659
1551	1467	1389	1320	1257	1200	1152	1107	1065	1026	991
2068	1955	1852	1760	1677	1600	1536	1476	1421	1369	1322
2586	2445	2315	2200	2096	2000	1920	1846	1777	1712	1653
3106	2936	2780	2641	2515	2400	2305	2215	2132	2055	1985
3628	3428	3245	3082	2935	2800	2688	2584	2488	2398	2316
4151	3922	3712	3542	3355	3200	3073	2953	2843	2741	2647
4677	4416	4179	3967	3776	3600	3456	3322	3198	3083	2977
5205	4913	4647	4410	4196	4000	3840	3691	3552	3424	3307
5736	5412	5117	4854	4617	4400	4224	4059	3906	3765	3636
6268	5912	5587	5298	5039	4800	4607	4428	4261	4106	3965
6803	6414	6059	5744	5460	5200	4991	4795	4614	4447	4293
7340	6917	6531	6189	5882	5600	5374	5163	4967	4786	4620
7880	7422	7005	6636	6304	6000	5757	5530	5319	5125	4947
8422	7929	7481	7083	6727	6400	6140	5897	5671	5464	5273
8966	8438	7957	7531	7149	6800	6522	6263	6023	5801	5599
9513	8947	8434	7980	7572	7200	6905	6629	6374	6138	5923
10062	9460	8912	8429	7996	7600	7287	6995	6724	6475	6247
10615	9974	9392	8879	8420	8000	7669	7361	7075	6811	6570

LONG RANGE CRUISE ENROUTE FUEL AND TIME – HIGH ALTITUDE

Fuel And Time Required

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	29		31		33		35		37	
	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)
400	10.8	0:59	10.4	0:58	10.1	0:58	9.8	0:57	9.6	0:57
800	23.4	1:53	22.7	1:50	22.2	1:48	21.7	1:47	21.3	1:47
1200	35.9	2:46	34.8	2:42	34.1	2:39	33.4	2:37	32.9	2:36
1600	48.2	3:41	46.8	3:35	45.9	3:30	44.9	3:27	44.2	3:26
2000	60.3	4:36	58.5	4:28	57.3	4:22	56.2	4:17	55.3	4:16
2400	72.2	5:31	70.1	5:22	68.6	5:14	67.3	5:08	66.2	5:06
2800	84.1	6:27	81.5	6:17	79.8	6:07	78.2	5:59	76.9	5:55
3200	95.9	7:24	92.6	7:12	90.6	7:00	88.9	6:51	87.3	6:46
3600	107.4	8:21	103.6	8:07	101.3	7:54	99.4	7:43	97.6	7:37
4000	118.8	9:19	114.5	9:03	111.9	8:49	109.7	8:36	107.8	8:28
4400	129.9	10:18	125.1	10:00	122.2	9:44	119.8	9:30	117.7	9:19
4800	140.9	11:18	135.5	10:58	132.4	10:40	129.7	10:24	127.5	10:11
5200	151.8	12:19	145.9	11:56	142.4	11:36	139.5	11:18	137.2	11:04
5600	162.3	13:20	156.0	12:55	152.2	12:33	149.1	12:13	146.6	11:57
6000	172.8	14:22	165.9	13:55	161.9	13:30	158.5	13:09	155.8	12:51
6400	183.0	15:25	175.7	14:55	171.4	14:28	167.8	14:05	165.0	13:45
6800	193.1	16:29	185.5	15:57	180.9	15:28	177.1	15:02	174.1	14:40
7200	203.0	17:34	195.2	16:59	190.4	16:27	186.2	16:00	183.0	15:36
7600	212.8	18:39	204.7	18:02	199.7	17:28	195.3	16:58	191.9	16:32
8000	222.3	19:46	214.0	19:06	208.7	18:30	204.1	17:57	200.6	17:29

Fuel Required Adjustment (1000)

REFERENCE FUEL REQUIRED (1000 LB)	WEIGHT AT CHECKPOINT (1000 LB)				
	300	400	500	600	700
10	-1.5	-0.5	0.0	3.5	12.0
20	-4.0	-1.7	0.0	5.8	18.7
30	-6.4	-2.8	0.0	8.0	25.0
40	-8.9	-4.0	0.0	10.1	31.0
50	-11.3	-5.2	0.0	12.1	36.7
60	-13.8	-6.3	0.0	14.1	42.1
70	-16.3	-7.5	0.0	16.0	47.2
80	-18.9	-8.8	0.0	17.9	51.9
90	-21.4	-10.0	0.0	19.6	56.3
100	-23.9	-11.2	0.0	21.3	60.4

Based on LRC and .84/310/250 descent.

.84/310/250 Descent

Distance and time for descent are shown for a .84/310/250 descent speed schedule. Enter the table with top of descent pressure altitude and read distance in nautical miles and time in minutes. Data is based on flight idle thrust descent in zero wind from top of descent to sea level. Allowances are included for a straight-in approach with gear down and landing flaps 30 at the outer marker.

.84/310/250 DESCENT

PRESSURE ALT (1000 FT)	25	27	29	31	33	35	37	39	41	43
DISTANCE (NM)	99	106	112	119	125	130	133	141	147	152
TIME (MIN)	20	21	22	22	23	24	24	25	26	27

Holding

Target %N₁ and fuel flow per engine information is tabulated for holding with flaps up based on the FMC optimum holding speed schedule. This is the higher of the maximum endurance speed and the maneuvering speed for the selected flap setting. Flaps 1 is based on V_{REF} +60 speed schedule. Small variations in airspeed will not appreciably affect the overall endurance time. Enter the table with weight and pressure altitude to read %N₁, IAS and fuel flow per engine.

HOLDING

Flaps UP

WEIGHT (1000 LB)		PRESSURE ALTITUDE (FT)									
		1500	5000	10000	15000	20000	25000	30000	35000	40000	43000
660	%N ₁	65.2	68.0	71.8	76.4	81.2	86.4	91.5			
	KIAS	270	271	273	274	277	279	283			
	FF/ENG	9010	8980	8710	8720	8900	9090	9660			
620	%N ₁	63.4	66.2	70.0	74.6	79.3	84.4	89.5	95.2		
	KIAS	262	263	264	266	268	270	280	280		
	FF/ENG	8660	8630	8370	8300	8420	8410	8880	9800		
580	%N ₁	61.7	64.4	68.0	72.7	77.4	82.3	87.6	92.3		
	KIAS	254	254	255	257	259	261	280	280		
	FF/ENG	8120	8080	7830	7720	7810	7760	8230	8760		
540	%N ₁	59.8	62.5	66.0	70.6	75.2	80.2	85.9	90.3		
	KIAS	245	245	246	247	249	251	280	280		
	FF/ENG	7590	7520	7280	7160	7220	7290	7700	8030		
500	%N ₁	57.8	60.4	63.9	68.5	73.0	78.1	84.4	88.7	96.7	
	KIAS	235	236	237	238	239	250	280	280	249	
	FF/ENG	7060	6970	6750	6610	6640	6800	7260	7500	8190	
460	%N ₁	55.8	58.2	61.7	66.4	70.6	76.4	82.9	87.3	92.4	
	KIAS	226	226	227	228	229	250	280	280	249	
	FF/ENG	6540	6420	6240	6080	6070	6380	6900	7070	7020	
420	%N ₁	53.6	56.0	59.3	64.0	68.0	74.7	81.6	86.1	89.9	94.9
	KIAS	216	216	217	218	219	250	280	280	249	232
	FF/ENG	6020	5890	5730	5560	5530	6010	6580	6730	6300	6750
380	%N ₁	51.5	53.6	56.8	61.5	65.3	73.1	80.3	84.9	88.0	91.2
	KIAS	207	207	207	207	208	250	280	280	249	232
	FF/ENG	5520	5380	5240	5050	5010	5680	6290	6420	5830	5800
340	%N ₁	49.2	51.3	54.3	59.0	62.6	71.7	79.0	83.7	86.4	88.7
	KIAS	200	200	200	200	200	250	280	280	249	232
	FF/ENG	5060	4910	4780	4580	4530	5390	6030	6120	5480	5350
300	%N ₁	46.7	48.7	51.6	56.2	59.7	70.4	78.0	82.6	85.0	86.9
	KIAS	192	192	192	192	192	250	280	280	249	232
	FF/ENG	4600	4460	4320	4130	4070	5130	5800	5860	5280	4970

HOLDING**Flaps 1**

WEIGHT (1000 LB)		PRESSURE ALTITUDE (FT)				
		1500	5000	10000	15000	20000
660	%N1	66.5	69.3	73.5	78.5	83.4
	KIAS	228	228	228	228	228
	FF/ENG	9450	9400	9240	9190	9280
620	%N1	64.6	67.4	71.5	76.6	81.3
	KIAS	222	222	222	222	222
	FF/ENG	9030	9000	8820	8720	8810
580	%N1	62.7	65.4	69.4	74.6	79.1
	KIAS	217	217	217	217	217
	FF/ENG	8430	8400	8220	8100	8170
540	%N1	60.6	63.4	67.2	72.4	76.9
	KIAS	211	211	211	211	211
	FF/ENG	7840	7800	7650	7510	7540
500	%N1	58.5	61.2	65.0	70.1	74.5
	KIAS	205	205	205	205	205
	FF/ENG	7260	7200	7080	6920	6930
460	%N1	56.4	58.9	62.7	67.7	72.0
	KIAS	199	199	199	199	199
	FF/ENG	6690	6600	6510	6350	6330
420	%N1	54.2	56.5	60.3	65.2	69.3
	KIAS	193	193	193	193	193
	FF/ENG	6130	6030	5960	5800	5760
380	%N1	51.7	54.0	57.6	62.5	66.5
	KIAS	187	187	187	187	187
	FF/ENG	5590	5480	5400	5250	5220
340	%N1	49.2	51.4	54.8	59.6	63.6
	KIAS	180	180	180	180	180
	FF/ENG	5060	4960	4850	4720	4690
300	%N1	46.4	48.6	51.8	56.5	60.5
	KIAS	172	172	172	172	172
	FF/ENG	4550	4450	4320	4210	4180

These tables include 5% additional fuel for holding in a racetrack pattern.

V_{REF} Speeds

The Reference Speed table contains flaps 30, 25, and 20 landing speeds for a given weight. Apply wind correction as required. For approach speed without using autothrottles add wind factor of ½ headwind component + gust (maximum 20 knots total).

WEIGHT (1000 LB)	V _{REF} FLAPS		
	20	25	30
660	180	174	166
640	177	171	164
620	174	168	161
600	172	166	158
580	169	163	155
560	165	160	152
540	163	158	150
520	160	154	147
500	157	151	144
480	153	147	141
460	149	144	138
440	147	142	135
420	143	138	132
400	139	134	128
380	136	132	125
360	132	128	122
340	129	125	119
320	126	122	116

FLAP MANEUVER SPEEDS

This table provides the flap speed schedule for minimum maneuver speeds. Using V_{REF} as the basis for the schedule makes it variable as a function of weight and will provide adequate maneuver margin above stall at all weights.

During flap retraction/extension, movement of the flap to the next position should be initiated when within 20 knots of the recommended speed for that position.

FLAP MANEUVER SPEED

Flap Position	Maneuver Speed
Flaps 0	V _{REF} 30 + 80
Flaps 1	V _{REF} 30 + 60
Flaps 5	V _{REF} 30 + 40
Flaps 15	V _{REF} 30 + 20
Flaps 20	V _{REF} 30 + 20
Flaps 25	V _{REF} 25
Flaps 30	V _{REF} 30

Go-Around Power Setting

To find Go-Around %N₁ base on normal engine bleed for packs on and anti-ice off, enter the Go-Around %N₁ table with airport pressure altitude and reported OAT or TAT and read %N₁. %N₁ adjustments are shown for engine bleeds for packs off, 2 packs from 1 bleed source, 1 pack, and wing anti-ice operations.

GO-AROUND %N₁

* Based on engine bleed for packs ON and anti-ice OFF.

Reported OAT		TAT	AIRPORT PRESSURE ALTITUDE (FT)							
°F	°C		-2000	0	1000	2000	3000	4000	5000	6000
133	56	60	96.9	97.4	97.3	97.3	97.4	97.5	97.5	97.6
124	51	55	98.3	98.7	98.7	98.7	98.8	98.9	98.9	99.0
115	46	50	99.7	100.2	100.2	100.2	100.2	100.2	100.3	100.4
106	41	45	100.9	101.7	101.6	101.6	101.6	101.6	101.7	101.7
97	36	40	101.6	102.9	102.9	102.9	102.8	102.8	102.7	102.8
88	31	35	101.4	103.5	103.5	103.4	103.4	103.4	103.4	103.4
79	26	30	100.6	102.9	103.5	103.9	103.9	104.0	104.1	104.1
70	21	25	99.8	102.1	102.6	103.1	103.6	104.2	104.5	104.7
61	16	20	98.9	101.2	101.8	102.3	102.7	103.3	103.9	104.5
52	11	15	98.1	100.4	100.9	101.4	101.9	102.4	103.0	103.6
45	7	10	97.2	99.5	100.0	100.5	101.0	101.5	102.1	102.7
36	2	5	96.4	98.6	99.1	99.6	100.1	100.6	101.2	101.8
27	-3	0	95.5	97.7	98.2	98.7	99.2	99.7	100.3	100.9
9	-13	-10	93.7	95.9	96.4	96.9	97.3	97.9	98.4	99.0
-9	-23	-20	91.9	94.1	94.6	95.0	95.5	96.0	96.5	97.1
-27	-33	-30	90.1	92.2	92.7	93.1	93.6	94.1	94.6	95.2
-45	-43	-40	88.2	90.3	90.7	91.2	91.6	92.1	92.6	93.2
-63	-53	-50	86.3	88.3	88.8	89.2	89.6	90.1	90.6	91.2

Reported OAT		TAT	AIRPORT PRESSURE ALTITUDE (FT)				<p>*Note: SEE %N₁ ADJUSTMENT TABLE FOR ENGINE BLEED ADJUSTMENTS</p>
°F	°C		7000	8000	9000	10000	
133	56	60	97.7	97.6	96.9	96.2	
124	51	55	99.1	99.0	98.3	97.6	
115	46	50	100.5	100.3	99.6	98.9	
106	41	45	101.8	101.6	101.0	100.3	
97	36	40	103.0	102.6	102.2	101.6	
88	31	35	103.4	103.1	102.7	102.4	
79	26	30	104.1	103.7	103.3	102.9	
70	21	25	105.1	104.8	104.3	103.8	
61	16	20	105.3	105.4	105.3	105.0	
52	11	15	104.4	105.0	105.3	105.4	
45	7	10	103.5	104.1	104.4	104.7	
36	2	5	102.6	103.2	103.5	103.8	
27	-3	0	101.7	102.2	102.5	102.9	
9	-13	-10	99.8	100.3	100.6	101.0	
-9	-23	-20	97.9	98.4	98.7	99.0	
-27	-33	-30	95.9	96.4	96.7	97.0	
-45	-43	-40	94.0	94.4	94.7	95.0	
-63	-53	-50	91.9	92.4	92.7	93.0	

%N_i ADJUSTMENTS FOR ENGINE BLEED

Bleed Configuration	Airport Pressure Altitude (FT)							
	-2000	0	1000	2000	3000	4000	5000	6000
Packs OFF	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4
1 Pack ON	-0.3	-0.3	-0.3	-0.3	-0.3	-0.4	-0.4	-0.4
Wing A/I ON	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3	-0.3	-0.3

Bleed Configuration	Airport Pressure Altitude (FT)			
	7000	8000	9000	10000
Packs OFF	0.4	0.5	0.5	0.5
1 Pack ON	-0.4	-0.5	-0.5	-0.5
Wing A/I ON	-0.3	-0.3	-0.3	-0.3

INTENTIONALLY LEFT BLANK

NON-NORMAL

ENGINE INOPERATIVE PERFORMANCE DATA**Max Continuous %N₁**

The Max Continuous thrust rating is intended primarily for emergency use at the discretion of the pilot and is the maximum thrust that may be used continuously. It is desirable to maintain engine thrust level within the limits of the Max Cruise thrust rating. However, where thrust level in excess of Max Cruise rating is required, such as for meeting terrain clearance, ATC altitude assignments, or to attain maximum range capability, it is permissible to use the thrust needed up to the Max Continuous thrust rating.

Power setting is based on one engine operating with one bleed source for pack(s) operating and all anti-ice bleeds off. Enter the table with pressure altitude and IAS or Mach to read %N₁.

ENGINE INOPERATIVE MAX CONTINUOUS %N_I

Based on engine bleed for packs ON or OFF and anti-ice OFF

37000 ft to 27000 ft Pressure Altitude

37000 FT PRESS ALT			TAT (°C)									
CIAS	M	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0
200	0.63	96.4	97.5	98.6	99.6	100.7	101.7	102.5	102.0	101.0	100.2	99.5
240	0.74	96.6	97.7	98.7	99.8	100.8	101.8	102.6	102.6	101.5	100.7	100.0
280	0.86	95.2	96.3	97.4	98.4	99.4	100.4	101.4	102.4	102.0	101.0	100.3
35000 FT PRESS ALT			TAT (°C)									
CIAS	M	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0
200	0.60	96.2	97.3	98.4	99.4	100.4	101.5	102.6	102.8	101.8	100.8	100.0
240	0.71	96.4	97.4	98.5	99.5	100.6	101.6	102.6	103.2	102.3	101.2	100.5
280	0.82	96.1	97.2	98.2	99.3	100.3	101.3	102.3	103.3	102.8	101.7	100.8
33000 FT PRESS ALT			TAT (°C)									
CIAS	M	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0
200	0.58	96.5	97.6	98.7	99.7	100.7	101.8	102.3	102.1	101.4	100.4	99.7
240	0.68	96.0	97.1	98.2	99.2	100.2	101.3	102.3	102.3	101.7	100.8	100.1
280	0.79	94.5	95.6	96.6	97.6	98.7	99.7	100.7	101.7	102.1	101.3	100.4
320	0.89	92.1	93.1	94.1	95.1	96.1	97.1	98.1	99.1	100.0	101.0	100.6
31000 FT PRESS ALT			TAT (°C)									
CIAS	M	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
200	0.55	97.3	98.4	99.4	100.5	101.5	102.3	102.3	101.4	100.4	99.6	98.9
240	0.66	96.6	97.7	98.7	99.7	100.8	101.8	102.4	101.7	100.6	99.9	99.3
280	0.76	94.8	95.9	96.9	97.9	98.9	99.9	100.9	101.9	101.2	100.3	99.7
320	0.85	92.5	93.5	94.5	95.5	96.5	97.4	98.4	99.3	100.3	100.6	100.0
29000 FT PRESS ALT			TAT (°C)									
CIAS	M	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10
200	0.53	98.3	99.4	100.4	101.4	102.4	102.9	102.4	101.3	100.3	99.6	99.0
240	0.63	97.5	98.5	99.6	100.6	101.6	102.6	102.4	101.6	100.7	99.9	99.4
280	0.73	95.9	96.9	97.9	98.9	99.9	100.9	101.9	102.1	101.1	100.4	99.9
320	0.82	93.7	94.7	95.7	96.7	97.6	98.6	99.5	100.5	101.4	100.7	100.1
360	0.91	91.5	92.5	93.5	94.4	95.4	96.3	97.3	98.2	99.1	100.0	100.3
27000 FT PRESS ALT			TAT (°C)									
CIAS	M	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10
200	0.51	98.3	99.3	100.4	101.4	102.4	103.3	103.2	102.2	101.1	100.2	99.5
240	0.60	97.3	98.3	99.3	100.3	101.3	102.3	103.1	102.3	101.3	100.5	99.9
280	0.70	95.6	96.7	97.7	98.7	99.7	100.6	101.6	102.6	101.8	101.0	100.3
320	0.79	93.7	94.7	95.7	96.7	97.6	98.6	99.6	100.5	101.4	101.4	100.7
360	0.88	91.6	92.6	93.6	94.5	95.5	96.4	97.3	98.3	99.1	100.1	100.8

%N_I ADJUSTMENTS FOR ENGINE BLEED

BLEED CONFIGURATION	PRESS ALT (1000 FT)					
	37	35	33	31	29	27
ENGINE ANTI-ICE ON	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
ENGINE & WING ANTI-ICE ON *	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
ENGINE & WING ANTI-ICE ON **	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4

* Wing anti-ice ON, packs ON.

** Wing anti-ice ON, packs OFF.

ENGINE INOPERATIVE MAX CONTINUOUS %N_I

Based on engine bleed for packs ON or OFF and anti-ice OFF

25000 ft to 18000 ft Pressure Altitude

25000 FT PRESS ALT												TAT (°C)	
KLAS	M	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	
200	0.49	99.3	100.4	101.4	102.4	103.4	103.7	103.0	101.9	100.9	100.1	99.4	
240	0.58	98.1	99.1	100.1	101.1	102.1	103.1	103.0	102.0	101.1	100.4	99.9	
280	0.67	96.3	97.3	98.3	99.3	100.3	101.2	102.2	102.4	101.5	100.8	100.3	
320	0.76	94.6	95.5	96.5	97.5	98.4	99.4	100.3	101.3	102.0	101.2	100.7	
360	0.85	92.7	93.6	94.6	95.6	96.5	97.4	98.3	99.3	100.2	101.1	100.9	
24000 FT PRESS ALT												TAT (°C)	
KLAS	M	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	
200	0.48	99.1	100.2	101.2	102.2	103.2	103.9	103.3	102.2	101.1	100.3	99.6	
240	0.57	97.8	98.9	99.9	100.9	101.9	102.8	103.3	102.4	101.4	100.7	100.1	
280	0.66	96.1	97.2	98.1	99.1	100.1	101.1	102.0	102.7	101.8	101.0	100.5	
320	0.75	94.4	95.4	96.4	97.4	98.3	99.3	100.2	101.1	102.1	101.5	100.9	
360	0.83	92.7	93.4	94.6	95.5	96.5	97.4	98.3	99.2	100.1	101.0	101.2	
22000 FT PRESS ALT												TAT (°C)	
KLAS	M	-30	-25	-20	-15	-10	-5	0	5	10	15	20	
200	0.46	99.9	100.9	101.9	102.9	103.9	103.6	102.5	101.3	100.4	99.8	99.2	
240	0.55	98.5	99.5	100.5	101.5	102.4	103.4	103.0	102.0	101.2	100.5	100.0	
280	0.63	96.7	97.7	98.7	99.7	100.6	101.6	102.5	102.3	101.5	100.9	100.4	
320	0.72	95.2	96.1	97.1	98.1	99.0	99.9	100.9	101.8	102.0	101.3	100.8	
360	0.80	93.4	94.4	95.3	96.3	97.2	98.1	99.0	99.9	100.8	101.5	101.1	
20000 FT PRESS ALT												TAT (°C)	
KLAS	M	-30	-25	-20	-15	-10	-5	0	5	10	15	20	
200	0.44	98.7	99.7	100.7	101.7	102.7	103.7	102.7	101.7	100.6	99.9	99.4	
240	0.53	98.0	99.0	100.0	100.9	101.9	102.9	103.7	102.7	101.8	101.0	100.4	
280	0.61	96.4	97.4	98.4	99.3	100.3	101.2	102.2	103.0	102.1	101.3	100.8	
320	0.69	94.8	95.8	96.7	97.7	98.6	99.6	100.5	101.4	102.3	101.6	101.1	
360	0.77	93.3	94.2	95.3	96.1	97.1	98.0	98.9	99.8	100.7	101.6	101.5	
18000 FT PRESS ALT												TAT (°C)	
KLAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	
200	0.42	98.7	99.7	100.7	101.7	102.7	103.1	101.9	100.8	99.9	99.2	98.4	
240	0.51	98.7	99.7	100.6	101.6	102.6	103.5	103.5	102.5	101.5	100.7	100.0	
280	0.59	96.9	97.9	98.9	99.8	100.8	101.7	102.6	102.6	101.8	101.1	100.5	
320	0.67	95.4	96.4	97.3	98.2	99.2	100.1	101.0	101.9	102.1	101.5	100.9	
360	0.75	94.0	94.9	95.8	96.8	97.7	98.6	99.5	100.4	101.3	101.7	101.2	

%N_I ADJUSTMENTS FOR ENGINE BLEED

BLEED CONFIGURATION	PRESS ALT (1000 FT)				
	25	24	22	20	18
ENGINE ANTI-ICE ON	-0.2	-0.2	-0.2	-0.2	-0.2
ENGINE & WING ANTI-ICE ON *	-0.3	-0.3	-0.3	-0.3	-0.3
ENGINE & WING ANTI-ICE ON **	-0.4	-0.4	-0.4	-0.4	-0.4

* Wing anti-ice ON, packs ON.

** Wing anti-ice ON, packs OFF.

ENGINE INOPERATIVE MAX CONTINUOUS %N₁

Based on engine bleed for packs ON or OFF and anti-ice OFF

16000 ft to 5000 ft Pressure Altitude

16000 FT PRESS ALT												TAT (°C)	
KLAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	
200	0.41	97.7	98.6	99.6	100.6	101.5	102.5	102.1	101.0	100.0	99.3	98.4	
240	0.49	97.7	98.7	99.7	100.6	101.6	102.5	103.5	102.7	101.6	100.8	100.1	
280	0.57	96.5	97.5	98.5	99.4	100.3	101.3	102.2	103.1	102.3	101.6	100.9	
320	0.64	95.0	96.0	96.9	97.9	98.8	99.7	100.6	101.5	102.4	101.8	101.3	
360	0.72	93.7	94.6	95.6	96.5	97.4	98.3	99.2	100.1	101.0	101.8	101.6	
14000 FT PRESS ALT												TAT (°C)	
KLAS	M	-20	-15	-10	-5	0	5	10	15	20	25	30	
200	0.39	97.9	98.9	99.8	100.8	101.7	102.6	101.5	100.5	99.8	99.0	98.1	
240	0.47	97.4	98.3	99.3	100.5	101.2	102.1	102.6	101.6	100.9	100.2	99.3	
280	0.54	97.1	98.1	99.0	100.0	100.9	101.8	102.7	103.0	102.2	101.5	100.8	
320	0.62	95.7	96.7	97.6	98.5	99.4	100.3	101.2	102.1	102.4	101.8	101.3	
360	0.69	94.4	95.3	96.3	97.2	98.1	99.0	99.9	100.7	101.6	102.0	101.5	
12000 FT PRESS ALT												TAT (°C)	
KLAS	M	-15	-10	-5	0	5	10	15	20	25	30	35	
200	0.38	98.3	99.3	100.2	101.1	102.1	102.6	101.4	100.7	99.9	99.1	98.2	
240	0.45	97.5	98.4	99.3	100.3	101.2	102.1	102.0	101.1	100.4	99.6	98.7	
280	0.52	97.8	98.7	99.6	100.6	101.5	102.4	103.3	102.9	102.2	101.5	100.7	
320	0.60	96.3	97.2	98.1	99.1	100.0	100.9	101.7	102.6	102.4	101.9	101.2	
360	0.67	95.1	96.1	97.0	97.9	98.8	99.6	100.5	101.4	102.2	102.0	102.5	
10000 FT PRESS ALT												TAT (°C)	
KLAS	M	-15	-10	-5	0	5	10	15	20	25	30	35	
200	0.36	97.9	98.8	99.8	101.1	101.6	102.5	102.4	101.5	100.8	100.1	99.2	
240	0.43	97.0	98.0	98.9	100.3	100.7	101.6	102.5	101.9	101.2	100.4	99.6	
280	0.51	96.8	97.8	98.7	100.6	100.5	101.4	102.3	103.0	102.2	101.7	100.9	
320	0.58	95.6	96.6	97.5	99.1	99.3	100.2	101.0	101.9	102.4	101.9	101.3	
360	0.65	94.5	95.5	96.4	97.9	98.1	99.0	99.9	100.7	101.6	102.1	101.6	
5000 FT PRESS ALT												TAT (°C)	
KLAS	M	-10	-5	0	5	10	15	20	25	30	35	40	
200	0.33	96.6	97.5	98.4	100.7	100.2	101.1	101.9	101.7	101.1	100.4	99.5	
240	0.40	96.0	96.9	97.8	99.8	99.6	100.5	101.3	102.0	101.4	100.7	99.8	
280	0.46	95.4	96.3	97.2	99.6	99.0	99.8	100.7	101.5	101.7	101.0	100.2	
320	0.53	94.6	95.5	96.4	98.4	98.2	99.0	99.9	100.7	101.6	101.3	100.5	
360	0.59	93.8	94.7	95.6	97.2	97.3	98.2	99.0	99.8	100.7	101.5	100.9	

%N₁ ADJUSTMENTS FOR ENGINE BLEED

BLEED CONFIGURATION	PRESS ALT (1000 FT)				
	16	14	12	10	5
ENGINE ANTI-ICE ON	-0.2	-0.2	-0.3	-0.3	-0.3
ENGINE & WING ANTI-ICE ON*	-0.3	-0.3	-0.4	-0.4	-0.4
ENGINE & WING ANTI-ICE ON**	-0.4	-0.4	-0.5	-0.5	-0.5

* Wing anti-ice ON, packs ON.

** Wing anti-ice ON, packs OFF.

Driftdown Speed/Level Off Altitude

The table shows optimum driftdown speed as a function of cruise weight at start of driftdown. Also shown are the approximate weight and pressure altitude at which the airplane will level off considering 100 ft/min residual rate of climb.

The level off altitude is dependent on air temperature (ISA deviation).

**ENGINE INOPERATIVE
DRIFTDOWN SPEED / LEVEL OFF ALTITUDE
(STARTING FROM OPTIMUM ALTITUDE)**

Max Continuous Thrust - 100 ft/min residual rate of climb

WEIGHT (1000 LB)		OPTIMUM DRIFTDOWN SPEED (KIAS)	LEVEL OFF PRESSURE ALTITUDE (FT)		
START DRIFT DOWN	LEVEL OFF		ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
660	640	281	15800	14600	13100
640	620	277	16700	15500	14100
620	600	273	17700	16500	15100
600	576	268	18600	17500	16100
580	562	264	19600	18500	17200
560	543	260	20600	19500	18300
540	524	256	21600	20500	19400
520	504	250	22600	21600	20500
500	485	247	23700	22700	21600
480	465	242	24600	23800	22700
460	446	237	25800	25000	23900
440	429	232	26800	26100	25100
420	408	227	27900	27300	26300
400	384	220	29000	28500	27400
380	369	216	30200	29800	28800
360	351	210	31400	31100	30200
340	330	204	32700	32400	31700
320	312	198	33900	33800	33400
300	291	192	35200	35200	31500

Driftdown/Cruise Range, Fuel And Time

This table shows the range capability from the start of driftdown. Driftdown is continued to level off altitude. As weight decreases due to fuel burn, the airplane is accelerated to long range cruise speed. Cruise is continued at level off altitude and long range cruise speed.

To determine fuel required, enter the Ground to Air Miles Conversion Table with the desired ground distance and correct for anticipated winds to obtain air distance to destination. Then enter the Driftdown/Cruise Fuel and Time Table with air distance and weight at start of driftdown to determine fuel and time required. If an altitude other than the level off altitude is used, fuel and time required may be obtained by using the Engine Inoperative Long Range Cruise Enroute Fuel and Time Table.

**ENGINE INOPERATIVE
MAX CONTINUOUS THRUST**

Driftdown LRC Range Capability**Ground To Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DIST. (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
133	125	118	111	105	100	95	91	87	83	80
272	254	238	224	211	200	190	181	173	165	158
410	382	358	336	317	300	285	271	258	247	236
548	510	477	448	423	400	380	361	344	329	315
684	637	596	560	528	500	474	451	430	411	394
820	764	715	672	634	600	569	542	517	494	473
955	890	834	784	740	700	664	632	603	577	552
1090	1016	952	895	845	800	760	723	690	660	632
1234	1142	1070	1007	950	900	855	814	777	743	711
1359	1268	1188	1118	1056	1000	950	904	863	826	791
1493	1393	1306	1229	1161	1100	1045	995	950	909	871
1627	1519	1424	1341	1266	1200	1140	1086	1037	992	951
1761	1645	1542	1452	1372	1300	1235	1177	1123	1075	1030
1896	1771	1661	1564	1477	1400	1330	1267	1210	1158	1110
2031	1897	1779	1675	1583	1500	1425	1358	1297	1241	1189
2166	2023	1898	1787	1688	1600	1520	1449	1383	1323	1268
2302	2150	2017	1899	1794	1700	1615	1539	1469	1406	1347
2439	2277	2136	2011	1900	1800	1710	1629	1555	1488	1426

DRIFTDOWN / CRUISE FUEL AND TIME

AIR DIST (NM)	REQUIRED FUEL (1000 LB)									TIME (H:M)
	WEIGHT AT START OF DRIFTDOWN (1000 LB)									
	340	380	420	460	500	540	580	620	660	
100	1.9	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.2	0:15
200	4.4	4.7	5.2	5.6	6.1	6.6	7.0	7.4	7.7	0:32
300	7.2	7.8	8.5	9.3	10.0	10.8	11.5	12.2	12.7	0:48
400	10.0	10.9	12.0	13.0	14.1	15.1	16.1	17.2	18.0	1:05
500	12.7	13.9	15.3	16.6	18.0	19.4	20.7	22.0	23.1	1:21
600	15.3	16.8	18.5	20.1	21.8	23.4	25.0	26.6	28.0	1:37
700	17.9	19.7	21.6	23.6	25.5	27.4	29.3	31.2	32.9	1:52
800	20.5	22.6	24.8	27.0	29.2	31.4	33.6	35.7	37.7	2:08
900	23.0	25.4	27.9	30.4	32.9	35.4	37.8	40.3	42.5	2:23
1000	25.6	28.2	31.0	33.8	36.6	39.3	42.0	44.7	47.3	2:38
1100	28.1	31.0	34.1	37.2	40.2	43.2	46.2	49.2	52.0	2:54
1200	30.6	33.8	37.1	40.5	43.8	47.1	50.3	53.6	56.7	3:09
1300	33.0	36.5	40.2	43.8	47.4	50.9	54.4	58.0	61.4	3:24
1400	33.5	39.3	43.2	47.0	50.9	54.7	58.5	62.3	66.0	3:40
1500	37.9	42.0	46.1	50.3	54.4	58.5	62.5	66.7	70.6	3:55
1600	40.3	44.6	49.1	53.5	57.9	62.2	66.5	70.9	75.2	4:11
1700	42.7	47.3	52.0	56.7	61.3	65.9	70.5	75.2	79.8	4:27
1800	45.1	49.9	54.9	59.8	64.7	69.6	74.5	79.4	84.3	4:43

APU fuel included.

Driftdown at optimum speed and cruise at LRC speed.

Long Range Cruise Altitude Capability

The table shows the maximum altitude that can be maintained at a given weight and air temperatures (ISA deviation), based on LRC speed, Max Continuous thrust, and 100 ft/min residual rate of climb.

ENGINE INOPERATIVE MAX CONTINUOUS THRUST

Long Range Cruise Control

WEIGHT (1000 LB)		PRESSURE ALTITUDE (1000 FT)							
		10	15	17	19	21	23	25	27
660	%N ₁	95.5							
	MACH	.585							
	KIAS	325							
	FF/ENG	19345							
620	%N ₁	93.8	98.2						
	MACH	.574	.623						
	KIAS	319	316						
	FF/ENG	18114	18532						
580	%N ₁	91.8	96.2	98.1					
	MACH	.560	.605	.628					
	KIAS	310	306	306					
	FF/ENG	16842	17024	17302					
540	%N ₁	89.8	94.1	95.8	97.8				
	MACH	.545	.587	.607	.632				
	KIAS	302	297	296	297				
	FF/ENG	15633	15629	15763	16091				
500	%N ₁	87.5	91.8	93.5	95.3	97.4			
	MACH	.530	.570	.588	.609	.634			
	KIAS	294	288	286	285	286			
	FF/ENG	14456	14338	14379	14506	14874			
460	%N ₁	85.1	89.4	91.1	92.9	94.7	96.8		
	MACH	.512	.553	.570	.588	.609	.635		
	KIAS	284	279	277	275	274	275		
	FF/ENG	13310	13116	13105	13133	13268	13631		
420	%N ₁	82.7	86.9	88.6	90.3	92.1	93.9	96.0	
	MACH	.495	.534	.551	.568	.586	.607	.633	
	KIAS	274	270	267	265	263	262	263	
	FF/ENG	12211	11983	11898	11880	11895	12026	12361	
380	%N ₁	80.3	84.1	85.8	87.5	89.2	91.0	92.8	94.8
	MACH	.479	.514	.531	.547	.564	.583	.604	.629
	KIAS	265	259	257	255	253	251	250	250
	FF/ENG	11182	10867	10786	10695	10654	10666	10759	11050
340	%N ₁	77.8	81.2	82.8	84.5	86.3	87.9	89.6	91.4
	MACH	.463	.493	.508	.525	.542	.559	.577	.598
	KIAS	256	248	246	244	243	240	239	237
	FF/ENG	10241	9755	9683	9600	9498	9444	9461	9523
300	%N ₁	75.2	78.4	79.7	81.1	82.8	84.6	86.3	87.9
	MACH	.446	.473	.486	.500	.516	.534	.551	.569
	KIAS	246	238	235	232	231	229	227	225
	FF/ENG	9370	8774	8636	8694	8582	8319	8265	8300

ENGINE INOPERATIVE MAX CONTINUOUS THRUST LONG RANGE CRUISE DIVERSION FUEL AND TIME

Ground To Air Miles Conversion

AIR DISTANCE (NM)					GROUND DIST. (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
284	262	243	226	213	200	191	182	174	167	161
569	525	454	454	425	400	382	366	351	337	324
855	790	682	682	639	600	573	549	526	505	486
1142	1054	910	910	852	800	764	732	701	673	648
1430	1320	1138	1138	1065	1000	956	914	876	841	809
1719	1585	1366	1366	1278	1200	1146	1096	1050	1008	970
2008	1851	1594	1594	1492	1400	1337	1278	1225	1176	1131
2298	2118	1823	1823	1705	1600	1528	1460	1399	1343	1292
2590	2386	2052	2052	1919	1800	1718	1643	1573	1509	1452

Reference Fuel And Time Required At Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		18		22		26	
	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)
200	7.8	0:39	6.8	0:38	6.1	0:36	5.6	0:35	5.3	0:33
400	16.4	1:15	15.0	1:12	14.0	1:09	13.3	1:06	13.3	1:01
600	24.9	1:51	23.0	1:47	21.7	1:42	20.8	1:37	21.1	1:29
800	33.4	2:27	31.1	2:21	29.4	2:15	28.3	2:08	28.9	1:57
1000	41.8	3:04	38.9	2:56	36.9	2:48	35.6	2:39	36.4	2:26
1200	50.1	3:40	46.8	3:31	44.4	3:22	42.9	3:11	43.8	2:55
1400	58.3	4:18	54.6	4:06	51.8	3:56	50.1	3:42	51.1	3:24
1600	66.4	4:55	62.3	4:42	59.1	4:29	57.1	4:15	58.2	3:54
1800	74.5	5:33	69.9	5:18	66.4	5:04	64.1	4:47	65.2	4:23

Fuel Required Adjustment (1000 LB)

REFERENCE FUEL REQUIRED (1000 LB)	WEIGHT AT CHECKPOINT (1000 LB)				
	300	400	500	600	700
5	-0.7	-0.4	0.0	0.7	1.4
10	-1.9	-1.0	0.0	1.8	3.5
15	-3.0	-1.6	0.0	3.0	5.6
20	-4.1	-2.2	0.0	4.1	7.8
25	-5.2	-2.8	0.0	5.3	9.9
30	-6.3	-3.3	0.0	6.5	12.1
35	-7.3	-3.9	0.0	7.6	14.3
40	-8.4	-4.5	0.0	8.8	16.5
45	-9.4	-5.1	0.0	10.0	18.7
50	-10.5	-5.6	0.0	11.2	20.9
55	-11.5	-6.2	0.0	12.4	23.2
60	-12.5	-6.8	0.0	13.6	25.4
65	-13.5	-7.3	0.0	14.8	27.7
70	-14.5	-7.9	0.0	16.0	30.0
75	-15.5	-8.4	0.0	17.2	32.3

ENGINE INOPERATIVE MAX CONTINUOUS THRUST

Holding
Flaps UP

WEIGHT (1000 LB)		PRESSURE ALTITUDE					
		1500	5000	10000	15000	20000	25000
660	%N ₁	84.2	87.3	92.3	97.2		
	KIAS	270	271	273	274		
	FF/ENG	17740	17230	17480	18170		
620	%N ₁	82.3	85.2	90.2	95.1		
	KIAS	262	263	264	266		
	FF/ENG	16540	16090	16190	16690		
580	%N ₁	80.3	83.1	88.0	92.9	98.7	
	KIAS	254	254	255	257	259	
	FF/ENG	15380	14980	14950	15310	16220	
540	%N ₁	78.3	81.1	85.6	90.6	95.7	
	KIAS	245	245	246	247	249	
	FF/ENG	14290	13890	13820	14030	14550	
500	%N ₁	76.1	78.8	83.1	88.1	93.1	
	KIAS	235	236	237	238	239	
	FF/ENG	13270	12840	12770	12830	13140	
460	%N ₁	73.7	76.4	80.6	85.5	90.5	97.1
	KIAS	226	226	227	228	229	250
	FF/ENG	12230	11820	11710	11710	11830	13260
420	%N ₁	71.2	73.8	77.9	82.6	87.5	94.7
	KIAS	216	216	217	218	219	250
	FF/ENG	11110	10840	10690	10630	10600	12170
380	%N ₁	68.4	71.0	75.1	79.7	84.4	92.8
	KIAS	207	207	207	207	208	250
	FF/ENG	9990	9940	9710	9550	9460	11300
340	%N ₁	65.6	68.1	72.1	76.8	81.1	91.0
	KIAS	200	200	200	200	200	250
	FF/ENG	9140	9260	8950	8730	8670	10560
300	%N ₁	62.5	65.1	68.8	73.6	77.7	89.5
	KIAS	192	192	192	192	192	250
	FF/ENG	8150	8330	8040	7810	7730	9960

This table includes 5% additional fuel for holding in a racetrack pattern.

ENGINE INOPERATIVE LANDING DISTANCE REQUIRED – FLAPS 20

LANDING DISTANCE AND CORRECTIONS (FT)									
REPORTED BRAKING ACTION	APPCH SPEED	REF. DIST FOR 400000 LB LND WT	WT CORR PER 10000 LB ABOVE/ BELOW 400000 LB	ALT CORR PER 1000 FT ABOVE S.L.	WIND CORR PER 10 KTS		SLOPE CORR PER 1%		APPCH SPEED PER 10 KTS ABOVE V _{app}
					HD WIND	TAIL WIND	UP HILL	DN HILL	
DRY	V _{REF} 20	3000	80/-50	70	-120	430	-40	40	240
GOOD		4260	80/-50	110	-210	740	-100	120	350
MED POOR		5970 7990	130/-130 190/-190	180 270	-340 -520	1260 2040	-240 -500	320 830	460 560

Actual (unfactored) distances from 50 ft. to stop are shown.

Assumes max manual braking.

TWO ENGINE INOPERATIVE DRIFTDOWN

ALTITUDE FEET	360,000 LBS				660,000 LBS	
	198 KIAS		270 KIAS		270 KIAS	
	Time Min	Dist. NM	Time Min	Dist. NM	Time Min	Dist. NM
40,000	26:36	125	17:36	106		
35,000	24:00	107	16:00	92	19:30	116
30,000	21:00	94	14:00	76	17:00	100
25,000	18:00	76	11:54	64	14:48	82
20,000	14:48	60	9:36	50	12:00	65
15,000	11:30	50	7:30	38	9:18	49
10,000	8:00	30	5:00	25	6:12	32
5,000	4:00	15	3:18	12	3:18	16

Notes:

1. Inflight restart speed is 270 KIAS.
2. At 360,000 lbs. both optimum L/D speed (198 KIAS) and inflight restart speed (270 KIAS) are shown.
3. At 660,000 lbs. inflight restart speed of 270 KIAS and optimum L/D of 281 KIAS have negligible flight path differences.

GEAR DOWN

Note: The FMC does not contain special provisions for operation with landing gear extended. As a result, the FMC will generate inaccurate enroute speed schedules, display non-conservative predictions of fuel burn, estimated time of arrival (ETA), and maximum altitude, and compute overly shallow descent path.

To obtain accurate ETA predictions, gear down cruise speed and altitude should be entered on the CLB and CRZ pages of the CDU. Gear down cruise speed should also be entered on the DES page and a STEP SIZE of zero should be entered on the PERF INIT or CRZ page. Use of the VNAV during descent, under these circumstances is not recommended.

This section contains performance for airplane operation with the landing gear extended. The data is based on engine bleeds for normal air conditioning.

Tables for gear down performance in this section are identical in format and used in the same manner as tables for the gear up configuration previously described.

Gear Down Landing Rate Of Climb Available

Rate of climb data is provided as guidance information in the event that an engine inoperative autoland is planned. The tables show gear down rate of climb available for flaps 20. Enter the table with TAT and pressure altitude to read rate of climb available. Apply adjustments shown to correct for weight.

**ENGINE INOPERATIVE
GEAR DOWN LANDING RATE OF CLIMB AVAILABLE**

Flaps 20

TAT (°C)	RATE OF CLIMB (FT/MIN)					
	PRESSURE ALTITUDE (FT)					
	-2000	0	2000	4000	6000	8000
52	490	380				
50	540	420	290			
48	590	480	330			
46	640	530	380	240		
44	690	580	430	290		
42	730	640	480	330	190	
40	770	690	540	380	240	
38	810	740	580	420	290	130
36	850	780	630	470	320	160
34	890	820	660	500	370	200
32	900	860	690	540	380	220
30	900	900	730	570	410	240
20	930	920	820	700	570	410
10	950	940	840	720	600	470
0	980	970	860	730	610	480
-20	1020	1010	890	760	640	500
-40	1060	1050	930	800	660	520

Rate of climb capability shown is valid for 400,000 lbs. gear down at $V_{REF} 20 + 5$. Decrease rate of climb 50 ft/min per 10,000 lbs. greater than 400,000 lbs. Increase rate of climb 70 ft/min per 10,000 lbs. less than 400,000 lbs.

ENGINE INOPERATIVE – GEAR DOWN

Short Trip Fuel And Time

Ground To Air Miles Conversion

AIR DISTANCE (NM)					GROUND DIST. (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
101	84	72	63	56	50	45	42	38	36	33
173	151	134	120	109	100	92	86	80	75	70
247	218	196	178	163	150	139	130	121	114	108
319	285	258	235	216	200	186	174	163	154	146
391	351	319	292	269	250	233	218	206	194	184
462	417	380	349	323	300	280	263	248	234	222
534	483	441	406	376	350	327	308	290	274	260
606	549	502	463	429	400	375	352	332	315	299
678	615	564	520	482	450	422	397	374	355	337
751	682	625	577	536	500	469	441	417	395	375

Trip Fuel And Time

AIR DISTANCE (NM)		LANDING WEIGHT (1000 LB)					TIME (HRS:MIN)
		300	350	400	450	500	
50	FUEL (1000 LB) ALT (FT)	3.9 12000	4.3 12000	4.6 10000	4.9 10000	5.3 8000	0:15
100	FUEL (1000 LB) ALT (FT)	6.7 24000	7.3 22000	7.9 20000	8.6 18000	9.3 16000	0:25
150	FUEL (1000 LB) ALT (FT)	9.1 30000	10.0 26000	11.0 24000	11.9 22000	12.9 20000	0:35
200	FUEL (1000 LB) ALT (FT)	11.4 32000	12.7 28000	13.9 26000	15.1 24000	16.4 22000	0:45
250	FUEL (1000 LB) ALT (FT)	13.7 32000	15.2 30000	16.8 28000	18.3 24000	20.0 24000	0:54
300	FUEL (1000 LB) ALT (FT)	16.0 32000	17.8 30000	19.7 28000	21.5 26000	23.5 24000	1:03
350	FUEL (1000 LB) ALT (FT)	18.2 32000	20.4 30000	22.5 28000	24.8 26000	27.1 24000	1:12
400	FUEL (1000 LB) ALT (FT)	20.5 32000	23.0 30000	25.5 28000	28.0 26000	30.8 22000	1:21
450	FUEL (1000 LB) ALT (FT)	22.9 32000	25.6 30000	28.4 28000	31.2 26000	34.4 22000	1:31
500	FUEL (1000 LB) ALT (FT)	25.2 32000	28.2 30000	31.3 28000	34.5 26000	38.0 22000	1:40

ENGINE INOPERATIVE – GEAR DOWN**Max Continuous Thrust Long Range Cruise Control**

WEIGHT (1000 LB)		PRESSURE ALTITUDE (1000 FT)						
		5	7	9	11	13	15	17
540	%N ₁	98.3						
	MACH	.382						
	KIAS	231						
	FF/ENG	23363						
500	%N ₁	96.0	98.0					
	MACH	.372	.386					
	KIAS	225	225					
	FF/ENG	21555	21666					
460	%N ₁	93.7	95.6	97.7				
	MACH	.362	.376	.390				
	KIAS	219	219	219				
	FF/ENG	19847	19877	20113				
420	%N ₁	91.2	93.1	95.1	97.2			
	MACH	.352	.365	.379	.394			
	KIAS	213	213	213	213			
	FF/ENG	18236	18229	18353	18580			
380	%N ₁	88.4	90.4	92.5	94.4	96.5		
	MACH	.342	.354	.368	.382	.397		
	KIAS	207	207	207	207	207		
	FF/ENG	16680	16652	16745	16843	17080		
340	%N ₁	85.5	87.5	89.6	91.6	93.5	95.6	98.6
	MACH	.330	.343	.256	.369	.383	.399	.414
	KIAS	200	200	200	200	200	200	200
	FF/ENG	15186	15133	15186	15255	15371	15562	15939
300	%N ₁	82.5	84.3	86.4	88.4	90.4	92.4	94.5
	MACH	.318	.330	.343	.356	.370	.384	.399
	KIAS	192	192	192	192	192	192	192
	FF/ENG	13745	13687	13698	13728	13796	13899	14012

ENGINE INOPERATIVE – GEAR DOWN**Max Continuous Thrust Long Range Cruise Diversion Fuel And Time
Ground To Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DIST. (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
168	149	132	119	109	100	94	89	84	80	77
347	304	269	241	219	200	187	176	166	157	150
527	461	405	363	329	300	281	263	248	235	223
707	618	542	485	439	400	374	351	330	312	296
888	775	680	607	549	500	467	438	412	389	369
1071	993	818	729	660	600	561	525	494	466	442
1254	1092	956	852	770	700	654	612	575	543	515
1438	1252	1094	975	881	800	747	699	656	619	587
1623	1411	1233	1098	991	900	840	782	737	695	659
1809	1572	1373	1221	1102	1000	932	872	818	771	731

ENGINE INOPERATIVE – GEAR DOWN

Max Continuous Thrust Long Range Cruise Diversion Fuel And Time
Reference Fuel And Time Required At Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	6		8		10		12		14	
	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)	FUEL (1000 LB)	TIME (H:M)
100	7.2	0:27	6.8	0:26	6.5	0:25	6.3	0:25	6.1	0:24
200	14.7	0:53	14.2	0:52	13.7	0:50	13.3	0:49	13.0	0:48
300	22.2	1:20	21.5	1:18	20.8	1:16	20.3	1:13	20.0	1:11
400	29.8	1:47	28.8	1:44	28.0	1:41	27.3	1:38	26.9	1:35
500	37.0	2:14	35.9	2:10	34.9	2:06	34.1	2:02	33.6	1:59
600	44.3	2:41	43.0	2:36	41.9	2:32	40.8	2:27	40.2	2:23
700	51.6	3:08	50.1	3:03	48.8	2:57	47.6	2:52	46.9	2:47
800	58.9	3:36	57.2	3:29	55.7	3:23	54.4	3:17	53.6	3:11
900	66.0	4:03	64.1	3:56	62.4	3:49	60.9	3:42	60.0	3:35
1000	73.0	4:31	71.0	4:23	69.2	4:15	67.5	4:07	66.4	4:00

Fuel Required Adjustment (1000 LB)

REFERENCE FUEL REQUIRED (1000 LB)	WEIGHT AT CHECKPOINT (1000 LB)				
	300	350	400	450	500
10	-1.2	-0.6	0.0	1.2	2.3
15	-1.9	-1.0	0.0	1.9	3.8
20	-2.6	-1.3	0.0	2.6	5.2
25	-3.3	-1.7	0.0	3.3	6.7
30	-3.9	-2.0	0.0	4.0	8.1
35	-4.6	-2.3	0.0	4.7	9.5
40	-5.3	-2.7	0.0	5.4	10.9
45	-6.0	-3.0	0.0	6.1	12.3
50	-6.6	-3.4	0.0	6.8	13.7
55	-7.3	-3.7	0.0	7.4	15.1
60	-8.0	-4.0	0.0	8.1	16.4
65	-8.6	-4.4	0.0	8.7	17.8
70	-9.3	-4.7	0.0	9.3	19.1
75	-10.0	-5.0	0.0	10.0	20.4

ENGINE INOPERATIVE – GEAR DOWN

Max Continuous Thrust Holding

Flaps UP

WEIGHT (1000 LB)		PRESSURE ALTITUDE			
		1500	5000	10000	15000
540	%N ₁	94.9	98.3		
	KIAS	231	231		
	FF/ENG	24870	24530		
500	%N ₁	92.6	96.0		
	KIAS	225	225		
	FF/ENG	23040	22630		
460	%N ₁	90.2	93.7	99.0	
	KIAS	219	219	219	
	FF/ENG	21220	20840	21330	
420	%N ₁	87.7	91.2	96.2	
	KIAS	213	213	213	
	FF/ENG	19450	19150	19360	
380	%N ₁	85.0	88.4	93.5	
	KIAS	207	207	207	
	FF/ENG	17750	17510	17630	
340	%N ₁	82.3	85.5	90.6	95.6
	KIAS	200	200	200	200
	FF/ENG	16090	15950	15980	16340
300	%N ₁	79.5	82.5	87.5	92.4
	KIAS	192	192	192	192
	FF/ENG	14520	14430	14400	14590

These tables include 5% additional fuel for holding in a racetrack pattern.

ADVISORY INFORMATION

AUTOBRAKES LANDING DISTANCE

The Autobrakes Landing Distance Table is provided as advisory information to assist in the selection of the most desirable autobrake setting for a given field length. This data reflects actual landing distances on a dry runway for setting 1 through MAX AUTO, from touchdown to full stop, with or without reverse thrust. The table includes typical flare distances from threshold.

To use the Automatic Wheel Brakes Landing Distance Table, first determine the available (or desired) landing distance. Enter the chart with the estimated approach speed and determine the actual stopping distance from touchdown for a given autobrake setting. If airspeed is used for approach speed, correct landing distance for pressure altitude, tailwind and temperature effects.

Selection of an autobrake setting results in a constant rate of deceleration. Maximum effect manual braking should achieve shorter landing distance than the MAX AUTO setting.

AUTOMATIC WHEEL BRAKES LANDING DISTANCE

Reference Landing Distance (FT)

AUTOBRAKE SETTING	APPROACH SPEED (KIAS)						
	110	120	130	140	150	160	170
1	5000	5820	6710	7670	8690	9770	10910
2	4480	5200	5980	6820	7700	8650	9650
3	4000	4630	5310	6030	6800	7620	8480
4	3410	3940	4500	5100	5735	6400	7110
MAX AUTO	2880	3290	3720	4170	4650	5170	5750

Actual (unfactored) distances from 50 ft. to stop are shown.

The distances are valid with or without reverse thrust.

If entering chart with ground speed, ignore corrections below.

Landing Distance Adjustments (FT)

AUTOBRAKE SETTING	ALTITUDE CORR. PER 1000 FT ABOVE S.L.	TAILWIND CORR. PER 10 KTS	TEMP CORR. PER 10°C ABOVE ISA
1	240	1010	280
2	210	890	240
3	180	770	210
4	150	630	170
MAX AUTO	110	480	130

Slush / Standing Water

Experience has shown that aircraft performance may deteriorate significantly on runways covered with snow, slush, standing water or ice. Takeoffs in slush depths greater than one-half inch are not recommended because of possible airplane damage as a result of slush impingement on the airplane structure. The use of assumed temperature for reduced thrust is not allowed on contaminated runways.

Slippery Runway

The guidance data provided reflects conservative judgement but is not representative of the absolute worse case. If the surface is affected by water, snow or ice, and the braking action is reported as “good”, conditions should not be expected to be as good as on clean, dry runways. The value “good” is comparative and is intended to mean that airplanes should not experience braking or directional control difficulties when landing. Read actual landing distance for the reported braking action and apply the corrections for actual weight, airport pressure altitude, wind, approach speed and runway slope as required.

Use of the autobrake system commands the airplane to a constant deceleration rate. In some conditions, such as a runway with poor braking action, the airplane may not be able to achieve these deceleration rates. In these cases, the stopping distance becomes influenced by runway slope. Since it cannot be determined quickly when this becomes a factor, it is conservative to add the effects of downhill slope when using the autobrake system. Corrections for slope should always be considered when using manual braking.

SLIPPERY RUNWAY LANDING DISTANCE

Reference Landing Distance (FT)

BRAKING CONFIGURATION	REPORTED BRAKING ACTION			
	DRY	GOOD	MEDIUM	POOR
MAX MANUAL BRAKING	2710	3680	4880	6190
AUTOBRAKE SETTING 3	4225	5200	6740	10850
AUTOBRAKE SETTING 4	4410	4560	6660	10830
MAX AUTOBRAKE SETTING	3660	4470	6660	10830

Landing Distance Adjustments (FT)

CONDITIONS		CORRECTIONS			
		DRY	GOOD	MED	POOR
WEIGHT	PER 10,000 LB BELOW 400,000 LB	-79	-90	-120	-120
	PER 10,000 LB ABOVE 400,000 LB	89	90	120	160
AIRPORT PRESSURE ALTITUDE	PER 1000 FT ABOVE SEA LEVEL	100	110	180	320
WIND	PER 10 KTS HEADWIND	-190	-240	-400	-770
	PER 10 KTS TAILWIND	700	880	1600	3550
APPROACH SPEED	PER 10 KTS ABOVE V_{REF}	420	460	520	620
SLOPE	PER 1% DOWNHILL SLOPE	20	100	460	2680
	PER 1% UPHILL SLOPE	-20	-70	-320	-980

Actual (unfactored) distances from 50 ft. to stop are shown.

Based on flaps 30, V_{REF} 30 approach speed.

Max manual braking includes reverse thrust.

Autobrake data does not include use of reverse thrusts.

Non-Normal Configuration Landing Distance

Landing distances are shown for dry runway, good, medium and poor reported braking action. Each non-normal is listed with its recommended approach speed. Landing distance can be determined for the reference landing weight and then corrected for actual weight, pressure altitude, wind and slope conditions.

DRY RUNWAY NON-NORMAL CONFIGURATION LANDING DISTANCE

LANDING DISTANCE AND CORRECTIONS (FT)									
EICAS MESSAGES	APPCH SPEED	REF. DIST. FOR 400000 LB LND WT	WT CORR PER 10000 LB ABOVE/ BELOW 400000 LB	ALT. CORR PER 1000 FT ABOVE S.L.	WIND CORR PER 10 KTS		SLOPE CORR PER 1%		APPCH SPEED PER 10 KTS ABOVE V _{app}
					HD WIND	TAIL WIND	DN HILL	UP HILL	
ANTISKID	V _{REF} +30	4880	±110	151	-280	1120	230	-170	380
FLAPS DRIVE (FLAPS LESS THAN OR EQUAL TO 5)	V _{REF} 30 +40	3460	+120 -40	89	-141	480	50	-40	250
FLAPS DRIVE (FLAPS BETWEEN 5 AND 20)	V _{REF} 30 +20	3150	+88 -40	69	-122	450	40	-40	220
FLAPS DRIVE (FLAPS GTR THAN OR EQUAL TO 20)	V _{REF} 20	2950	+88 -40	69	-122	430	40	-30	220
FLAPS PRIMARY FAIL	V _{REF} 20	3320	+80 -50	69	-131	460	40	-40	280
FLAP/SLAT CONTROL	V _{REF} 20	2940	+88 -40	59	-121	430	40	-30	220
FLIGHT CONTROL MODE	V _{REF} 20	3400	+80 -50	79	-141	470	40	-40	300
HYD PRESS SYS C	V _{REF} 20	3320	+80 -50	69	-131	460	40	-40	280
HYD PRESS SYS L+C	V _{REF} 30 +20	3840	+80 -60	89	-151	520	60	-50	360
HYD PRESS SYS L+R	V _{REF} 30 +20	3850	+88 -50	89	-151	530	69	-60	370
HYD PRESS SYS R+C	V _{REF} 30 +20	3950	+80 -60	89	-161	540	69	-60	400
PITCH UP AUTHORITY (FLAPS 5)	V _{REF} 30 +40	3475	+110 -40	79	-141	480	40	-40	210
PITCH UP AUTHORITY (FLAPS 20)	V _{REF} 30 +20	3065	+88 -40	69	-121	440	40	-40	210
PRIMARY FLIGHT COMPUTER	V _{REF} 20	3400	+80 -50	79	-141	470	40	-40	300
SLATS DRIVE	V _{REF} 30 +30	3430	+88 -50	79	-131	460	40	-40	240
STABILIZER	V _{REF} 30 +20	3190	+88 -50	69	-121	440	40	-40	230

Actual (unfactored) distances are shown.

Landing distance includes 1000 ft of air distance.

NON-NORMAL CONFIGURATION LANDING DISTANCE

Good Reported Braking Action

LANDING DISTANCE AND CORRECTIONS (FT)									
EICAS MESSAGES	APPCD SPEED	REF. DIST. FOR 400000 LB LND WT	WT CORR PER 10000 LB ABOVE/ BELOW 400000 LB	ALT. CORR PER 1000 FT ABOVE S.L.	WIND CORR PER 10 KTS		SLOPE CORR PER 1%		APPCD SPEED
					HD WND	TAIL WND	DN HILL	UP HILL	
ANTISKID	V _{REF} +30	4910	+100/-100	150	-280	1120	230	-170	380
FLAPS DRIVE (FLAPS LESS THAN OR EQUAL TO 5)	V _{REF} 30 +40	4870	+80/-80	140	-210	770	110	-90	300
FLAPS DRIVE (FLAPS BETWEEN 5 AND 20)	V _{REF} 30 +20	4390	+70/-70	120	-200	740	100	-90	320
FLAPS DRIVE (FLAPS GTR THAN OR EQUAL TO 20)	V _{REF} 20	4080	+80/-80	110	-200	720	100	-80	310
FLAPS PRIMARY FAIL	V _{REF} 20	4500	+80/-80	120	-210	770	110	-100	380
FLAP/SLAT CONTROL	V _{REF} 20	4040	+70/-70	110	-200	710	100	-80	310
FLIGHT CONTROL MODE	V _{REF} 20	4630	+90/-90	120	-220	780	120	-100	410
HYD PRESS SYS C	V _{REF} 20	4500	+80/-80	120	-210	770	110	-100	380
HYD PRESS SYS L+C	V _{REF} 30 +20	5550	+90/-90	160	-260	910	180	-150	510
HYD PRESS SYS L+R	V _{REF} 30 +20	5940	+90/-90	170	-290	1040	250	-200	580
HYD PRESS SYS R+C	V _{REF} 30 +20	5700	+100/-100	160	-260	950	190	-160	550
PITCH UP AUTHORITY (FLAPS 5)	V _{REF} 30 +40	4850	+80/-80	130	-210	760	100	-90	290
PITCH UP AUTHORITY (FLAPS 20)	V _{REF} 30 +20	4230	+70/-70	110	-200	720	100	-80	290
PRIMARY FLIGHT COMPUTER	V _{REF} 20	4630	+90/-90	120	-220	780	120	-100	410
SLATS DRIVE	V _{REF} 30 +30	4740	+80/-80	130	-220	780	110	-100	330
STABILIZER	V _{REF} 30 +20	4410	+80/-80	120	-200	750	110	-90	320

Actual (unfactored) distances are shown.

Landing distance includes 1000 ft. of air distance.

Assumes max manual braking.

NON-NORMAL CONFIGURATION LANDING DISTANCE

Medium Reported Braking Action

LANDING DISTANCE AND CORRECTIONS (FT)									
EICAS MESSAGES	APPCD SPEED	REF. DIST. FOR 400000 LB LND WT	WT CORR PER 10000 LB ABOVE/ BELOW 400000 LB	ALT. CORR PER 1000 FT ABOVE S.L.	WIND CORR PER 10 KTS		SLOPE CORR PER 1%		APPCD SPEED
					HD WND	TAIL WND	DN HILL	UP HILL	
ANTISKID	V _{REF} +30	4875	± 120	150	-280	1120	230	-170	380
FLAPS DRIVE (FLAPS LESS THAN OR EQUAL TO 5)	V _{REF} 30 +40	6550	± 140	220	-330	1260	260	-210	400
FLAPS DRIVE (FLAPS BETWEEN 5 AND 20)	V _{REF} 30 +20	5860	± 130	180	-310	1200	240	-190	400
FLAPS DRIVE (FLAPS GTR THAN OR EQUAL TO 20)	V _{REF} 20	5410	± 130	170	-300	1180	240	-190	400
FLAPS PRIMARY FAIL	V _{REF} 20	5890	± 140	180	-320	1240	270	-210	470
FLAP/SLAT CONTROL	V _{REF} 20	5350	± 120	160	-300	1160	230	-180	390
FLIGHT CONTROL MODE	V _{REF} 20	6080	± 140	190	-330	1260	290	-220	510
HYD PRESS SYS C	V _{REF} 20	5890	± 140	180	-320	1240	270	-210	470
HYD PRESS SYS L+C	V _{REF} 30 +20	7840	± 170	260	-420	1620	520	-380	660
HYD PRESS SYS L+R	V _{REF} 30 +20	9650	± 180	300	-560	2090	990	-660	840
HYD PRESS SYS R+C	V _{REF} 30 +20	8010	± 170	260	-420	1640	550	-400	690
PITCH UP AUTHORITY (FLAPS 5)	V _{REF} 30 +40	6460	± 130	200	-320	1240	250	-200	370
PITCH UP AUTHORITY (FLAPS 20)	V _{REF} 30 +20	5610	± 120	170	-310	1180	230	-180	370
PRIMARY FLIGHT COMPUTERS	V _{REF} 20	6080	± 140	190	-330	1260	290	-220	510
SLATS DRIVE	V _{REF} 30 +30	6240	± 130	200	-330	1240	260	-210	410
STABILIZER	V _{REF} 30 +20	5800	± 130	180	-320	1240	250	-200	400

Actual (unfactored) distances are shown.

Landing distance includes 1000 ft of air distance.

Assumes max manual braking.

NON-NORMAL CONFIGURATION LANDING DISTANCE

Poor Reported Braking Action

LANDING DISTANCE AND CORRECTIONS (FT)									
EICAS MESSAGES	APPCD SPEED	REF. DIST. FOR 400000 LB LND WT	WT CORR PER 10000 LB ABOVE/ BELOW 400000 LB	ALT. CORR PER 1000 FT ABOVE S.L.	WIND CORR PER 10 KTS		SLOPE CORR PER 1%		APPCD SPEED
					HD WND	TAIL WND	DN HILL	UP HILL	
ANTISKID	V _{REF} +30	6180	+155 -170	210	-420	1815	540	-320	430
FLAPS DRIVE (FLAPS LESS THAN OR EQUAL TO 5)	V _{REF} 30 +40	8320	± 200	300	-480	1960	610	-390	480
FLAPS DRIVE (FLAPS BETWEEN 5 AND 20)	V _{REF} 30 +20	7460	± 180	250	-460	1870	570	-360	470
FLAPS DRIVE (FLAPS GTR THAN OR EQUAL TO 20)	V _{REF} 20	6850	± 180	230	-450	1840	560	-350	460
FLAPS PRIMARY FAIL	V _{REF} 20	7360	± 200	250	-470	1910	610	-390	530
FLAP/SLAT CONTROL	V _{REF} 20	6750	± 180	230	-440	1820	550	-350	450
FLIGHT CONTROL MODE	V _{REF} 20	7620	± 210	270	-480	1950	650	-410	570
HYD PRESS SYS C	V _{REF} 20	7360	± 200	250	-470	1910	610	-390	530
HYD PRESS SYS L+C	V _{REF} 30 +20	10780	± 240	390	-700	2830	1600	-820	760
HYD PRESS SYS L+R	V _{REF} 30 +20	16440	± 210	590	-12 20	5180	5960	-2150	1050
HYD PRESS SYS R+C	V _{REF} 30 +20	10930	± 250	400	-710	2860	1710	-840	780
PITCH UP AUTHORITY (FLAPS 5)	V _{REF} 30 +40	8150	± 190	280	-470	1910	570	-370	430
PITCH UP AUTHORITY (FLAPS 20)	V _{REF} 30 +20	7070	± 180	240	-450	1840	550	-350	430
PRIMARY FLIGHT COMPUTER	V _{REF} 20	7620	± 210	270	-480	1950	650	-410	570
SLATS DRIVE	V _{REF} 30 +30	7790	± 190	270	-480	1920	600	-390	460
STABILIZER	V _{REF} 30 +20	7790	± 190	250	-460	1880	580	-370	460

Actual (unfactored) distances are shown.

Landing distance includes 1000 ft of air distance.

Assumes max manual braking.

Flight With Unreliable Airspeed

Body attitude and average %N₁ information is provided for use in all phases of flight in the event of unreliable airspeed/Mach indications resulting from blocking or freezing of the pitot system. Loss of radome may also cause unreliable airspeed/Mach indications. Climb, cruise and descent information is based on the recommended turbulent air penetration speed schedule which provides maximum protection from low and high speed buffet.

FLIGHT WITH UNRELIABLE AIRSPEED / TURBULENT AIR PENETRATION

Altitude and/or vertical speed indications may also be unreliable.

Climb

Flaps Up, Set Max Climb Thrust

PRESSURE ALTITUDE (FT)		WEIGHT (1000 LB)			
		350	450	550	650
40000 (.82M)	PITCH ATT V/S (FT/MIN)	4.0 1600	3.5 700		
30000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	4.5 2300	4.0 1600	4.0 1000	4.5 500
20000 (270 KIAS)	PITCH ATT V/S (FT/MIN)	7.0 3300	6.5 2400	6.0 1700	6.0 1200
10000 (270 KIAS)	PITCH ATT V/S (FT/MIN)	9.5 4300	8.5 3200	8.0 2400	7.5 1800
SEA LEVEL (270 KIAS)	PITCH ATT V/S (FT/MIN)	12.5 5200	10.5 3900	9.5 3000	9.0 2400

Cruise

Flaps Up, %N₁ for Level Flight

PRESSURE ALTITUDE (FT)		WEIGHT (1000 LB)			
		350	450	550	650
40000 (.82M)	PITCH ATT %N ₁	2.0 86.8	2.5 91.7		
35000 (280 KIAS)	PITCH ATT %N ₁	1.5 84.0	2.0 87.0	2.5 90.8	
30000 (280 KIAS)	PITCH ATT %N ₁	1.5 79.3	2.0 82.6	3.0 86.3	3.5 91.0
25000 (280 KIAS)	PITCH ATT %N ₁	1.5 75.2	2.5 78.1	3.0 81.6	4.0 85.9
20000 (270 KIAS)	PITCH ATT %N ₁	1.5 70.1	2.5 73.2	3.5 76.7	4.5 80.7
15000 (270 KIAS)	PITCH ATT %N ₁	1.5 65.9	2.5 68.7	3.5 72.1	4.5 76.0

FLIGHT WITH UNRELIABLE AIRSPEED / TURBULENT AIR PENETRATION (CONT'D)

Descent

Flaps Up, Set Idle Thrust

PRESSURE ALTITUDE (FT)		WEIGHT (1000 LB)			
		350	450	550	650
40000 (.82M)	PITCH ATT V/S (FT/MIN)	-1.5 -2700	-0.7 -2600		
30000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	-1.5 -2200	-0.5 -1900	0.5 -1900	1.0 -1900
20000 (270 KIAS)	PITCH ATT V/S (FT/MIN)	-1.0 -1800	0.0 -1600	1.0 -1600	2.0 -1600
10000 (270 KIAS)	PITCH ATT V/S (FT/MIN)	-1.5 -1700	0.0 -1500	1.0 -1400	2.0 -1400
SEA LEVEL (270 KIAS)	PITCH ATT V/S (FT/MIN)	-1.5 -1400	0.0 -1200	1.0 -1200	2.0 -1200

Holding

Flaps Up, %N₁ for Level Flight

PRESSURE ALTITUDE (FT)		WEIGHT (1000 LB)			
		350	450	550	650
10000	PITCH ATT	4.0	4.5	5.0	5.0
	%N ₁	54.9	60.9	66.2	71.1
	KIAS	201	218	233	253
5000	PITCH ATT	4.0	4.5	5.0	5.0
	%N ₁	51.9	57.4	62.6	67.3
	KIAS	201	218	232	252

Terminal Area (5000 FT)

%N₁ for Level Flight

FLAP POSITION (V _{REF} + INCREMENT)		WEIGHT (1000 LB)			
		350	400	450	500
FLAPS 0 (GEAR UP) (V _{REF} 30+80)	PITCH ATT	4.5	4.5	5.0	5.0
	%N ₁	51.6	54.6	57.5	60.3
FLAPS 1 (GEAR UP) (V _{REF} 30+60)	PITCH ATT	6.0	6.0	6.5	6.5
	%N ₁	51.9	55.1	58.2	61.1
FLAPS 5 (GEAR UP) (V _{REF} 30+40)	PITCH ATT	4.0	4.5	4.5	5.0
	%N ₁	56.4	60.1	63.6	66.6
FLAPS 15 (GEAR UP) (V _{REF} 30+20)	PITCH ATT	5.0	5.0	5.5	5.5
	%N ₁	53.4	56.8	60.0	62.9
FLAPS 20 (GEAR UP) (V _{REF} 30+20)	PITCH ATT	6.0	6.0	6.0	6.5
	%N ₁	54.6	58.2	61.6	64.6

Final Approach (1500 FT)

Gear Down, %N₁ for 3° Glideslope

FLAP POSITION (V _{REF} + INCREMENT)		WEIGHT (1000 LB)			
		350	400	450	500
FLAPS 25 (V _{REF} 25+10)	PITCH ATT	0.0	0.5	0.5	0.5
	%N ₁	48.5	51.6	54.3	56.9
FLAPS 30 (V _{REF} 30+10)	PITCH ATT	-0.5	0.0	0.0	0.0
	%N ₁	53.6	56.8	59.9	62.8

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Brake Cooling Schedule

Advisory information is provided to assist in avoiding problems associated with hot brakes. For normal operation, most landings are at weights below the quick turnaround limit weight. Application of the recommended cooling procedures shown will avoid brake overheat and fuse plug problems that could result from repeated landings at short time intervals or a rejected takeoff.

Brake temperature indications are also shown. If brake cooling is determined from the indications, the hottest brake indication should not be used until 10 to 15 minutes after the airplane has come to a complete stop, or inflight with gear retracted to determine recommended cooling schedule. An EICAS advisory message, BRAKE TEMP, will appear when any brake is registering 5 on the EICAS indication and disappears as the hottest brake cools with an EICAS indication of 3.5. Note that even without an EICAS advisory message, brake cooling is recommended.

BRAKE COOLING SCHEDULE

Reference Brake Energy (Millions of Foot Pound)

WGT (1000 LB)	OAT °C	BRAKES ON SPEED (KIAS)								
		80			100			120		
		PRESS ALT			PRESS ALT			PRESS ALT		
		0	2	4	0	2	4	0	2	4
660	0	23.5	24.8	26.0	33.2	35.1	37.0	44.0	46.7	49.4
	10	24.3	25.6	26.9	34.3	36.3	38.3	45.6	48.3	51.1
	20	24.9	26.3	27.6	35.3	37.3	39.4	46.9	49.8	52.7
	30	25.2	26.6	28.0	35.9	38.0	40.1	47.8	50.8	53.8
	40	25.1	26.5	27.9	35.9	38.1	40.2	48.1	51.2	54.2
620	0	22.5	23.6	24.8	31.6	33.4	35.2	41.8	44.4	46.9
	10	23.2	24.4	25.6	32.7	34.5	36.4	43.3	45.9	48.6
	20	23.8	25.1	26.3	33.6	35.5	37.5	44.6	47.3	50.0
	30	24.1	25.4	26.7	34.1	36.1	38.1	45.4	48.2	51.0
	40	23.9	25.2	26.5	34.1	36.2	38.2	45.7	48.5	51.4
575	0	21.4	22.6	23.7	30.0	31.7	33.4	39.6	42.0	44.4
	10	22.1	23.3	24.4	31.0	32.8	34.6	41.0	43.5	45.9
	20	22.7	23.9	25.1	31.9	33.7	35.6	42.2	44.8	47.3
	30	23.0	24.2	25.4	32.4	34.3	36.2	43.0	45.6	48.2
	40	22.8	24.0	25.3	32.4	34.3	36.2	43.2	45.9	48.6
530	0	20.5	21.5	22.5	28.5	30.1	31.7	37.4	39.6	41.8
	10	21.1	22.2	23.3	29.4	31.1	32.7	38.7	41.0	43.3
	20	21.7	22.8	23.9	30.2	32.0	33.7	39.8	42.2	44.6
	30	21.9	23.0	24.2	30.7	32.5	34.2	40.5	43.0	45.4
	40	21.7	22.9	24.0	30.6	32.4	34.2	40.7	43.2	45.7
485	0	19.5	20.5	21.5	26.9	28.4	29.9	35.2	37.2	39.3
	10	20.1	21.2	22.2	27.8	29.4	30.9	36.4	38.5	40.6
	20	20.7	21.7	22.7	28.6	30.2	31.8	37.4	39.6	41.8
	30	20.9	21.9	23.0	29.0	30.6	32.3	38.1	40.3	42.6
	40	20.7	21.7	22.8	28.9	30.6	32.2	38.1	40.5	42.8
440	0	18.6	19.5	20.4	25.4	26.8	28.2	32.9	34.8	36.7
	10	19.2	20.1	21.1	26.3	27.7	29.1	34.0	36.0	38.0
	20	19.7	20.6	21.6	27.0	28.4	29.9	35.0	37.0	39.1
	30	19.9	20.9	21.9	27.3	28.8	30.4	35.6	37.7	39.8
	40	19.6	20.6	21.7	27.2	28.7	30.3	36.6	37.7	39.9
400	0	17.7	18.6	19.4	23.9	25.2	26.4	30.6	32.4	34.1
	10	18.3	19.2	20.0	24.7	26.0	27.3	31.7	33.5	35.3
	20	18.7	19.6	20.5	25.3	26.7	28.1	32.5	34.4	36.3
	30	18.9	19.8	20.8	25.7	27.1	28.5	33.1	35.0	36.9
	40	18.7	19.6	20.5	25.5	26.9	28.3	33.0	35.0	37.0
350	0	16.8	17.6	18.4	22.4	23.5	24.7	28.3	29.9	31.5
	10	17.4	18.2	19.0	23.1	24.3	25.5	29.3	30.9	32.6
	20	17.8	18.7	19.5	23.7	25.0	26.2	30.1	31.8	33.5
	30	18.0	18.8	19.7	24.0	25.3	26.6	30.5	32.3	34.0
	40	17.7	18.6	19.5	23.8	25.1	26.4	30.5	32.2	34.0
310	0	16.0	16.8	17.5	20.9	21.9	23.0	26.0	27.4	28.9
	10	16.5	17.3	18.1	21.5	22.6	23.7	26.9	28.4	29.8
	20	16.9	17.7	18.5	22.1	23.2	24.4	27.6	29.1	30.6
	30	17.1	17.9	18.7	22.3	23.5	24.7	28.0	29.6	31.1
	40	16.8	17.6	18.4	22.1	23.3	24.5	27.9	29.5	31.1

To correct for wind, enter table with the brakes on speed minus one half the headwind or plus 1.5 times the tailwind.

If ground speed is used for brakes on speed, ignore wind and enter table with sea level, 15°C.

BRAKE COOLING SCHEDULE

Reference Brake Energy (Millions of Foot Pound)

WGT (1000 LB)	OAT °C	BRAKES ON SPEED (KIAS)								
		140			160			180		
		PRESS ALT			PRESS ALT			PRESS ALT		
		0	2	4	0	2	4	0	2	4
660	0	56.0	59.5	63.1	68.7	73.1	77.6	81.4	86.6	91.9
	10	57.9	61.5	65.2	70.9	75.3	79.8	83.7	88.9	94.1
	20	59.6	63.3	67.1	72.9	77.4	81.9	85.8	91.0	96.2
	30	60.9	64.7	68.5	74.4	79.0	83.6	87.5	92.7	97.9
	40	61.5	65.4	69.3	75.3	80.0	84.7	88.6	93.9	99.2
620	0	53.0	56.4	59.8	65.0	69.2	73.4	77.2	82.2	87.2
	10	54.9	58.3	61.8	67.2	71.4	75.7	79.4	84.4	89.4
	20	56.5	60.1	63.6	69.1	73.4	77.8	81.5	86.5	91.5
	30	57.7	61.4	65.0	70.6	75.0	79.4	83.2	88.3	93.3
	40	58.3	62.0	65.7	71.4	75.9	80.4	84.3	89.4	94.5
575	0	50.1	53.2	56.4	61.3	65.2	69.2	72.8	77.5	82.2
	10	51.8	55.1	58.3	63.4	67.4	71.4	75.0	79.8	84.5
	20	53.4	56.7	60.0	65.2	69.3	73.4	77.1	81.9	86.6
	30	54.5	57.9	61.3	66.6	70.8	75.0	78.7	83.5	88.3
	40	55.0	58.5	61.9	67.4	71.7	75.9	79.7	84.6	89.5
530	0	47.1	50.0	52.9	57.5	61.2	64.8	68.2	72.6	77.0
	10	48.7	51.8	54.8	59.5	63.2	67.0	70.4	74.8	79.3
	20	50.2	53.3	56.4	61.2	65.1	68.9	72.4	76.9	81.4
	30	51.2	54.4	57.6	62.5	66.5	70.4	73.9	78.5	83.1
	40	51.6	54.9	58.1	63.2	67.2	71.2	74.8	79.5	84.2
485	0	44.1	46.8	49.5	53.6	57.0	60.4	63.5	67.5	71.6
	10	45.6	48.4	51.2	55.4	58.9	62.4	65.6	69.7	73.9
	20	47.0	49.8	52.7	57.1	60.7	64.3	67.5	71.7	75.9
	30	47.9	50.9	53.8	58.3	62.0	65.6	68.9	73.3	77.6
	40	48.2	51.2	54.3	58.9	62.6	66.4	69.7	74.1	78.5
440	0	41.0	43.5	45.9	49.6	52.7	55.8	58.5	62.3	66.0
	10	42.4	45.0	47.5	51.3	54.5	57.7	60.5	64.4	68.2
	20	43.6	46.3	49.0	52.9	56.1	59.4	62.3	66.3	70.2
	30	44.5	47.2	49.9	54.0	57.3	60.7	63.7	67.7	71.7
	40	44.7	47.5	50.3	54.4	57.9	61.3	64.4	68.5	72.5
400	0	37.8	40.1	42.4	45.5	48.3	51.1	53.5	56.8	60.2
	10	39.1	41.5	43.8	47.1	50.0	52.9	55.3	58.8	62.3
	20	40.3	42.7	45.1	48.5	51.5	54.5	57.0	60.5	64.1
	30	41.0	43.5	46.0	49.5	52.5	55.6	58.2	61.8	65.5
	40	41.2	43.7	46.3	49.8	52.9	56.1	58.7	62.5	66.2
350	0	34.7	36.7	38.7	41.3	43.8	46.3	48.2	51.2	54.2
	10	35.8	38.0	40.1	42.7	45.3	47.9	49.9	53.0	56.1
	20	36.9	39.1	41.2	44.0	46.7	49.4	51.4	54.6	57.8
	30	37.5	39.8	42.0	44.8	47.6	50.4	52.4	55.7	59.0
	40	37.6	39.9	42.2	45.1	47.9	50.7	52.9	56.2	59.6
310	0	31.4	33.2	35.0	37.0	39.2	41.4	42.8	45.4	48.0
	10	32.5	34.4	36.2	38.3	40.6	42.8	44.3	47.0	49.7
	20	33.4	35.3	37.3	39.4	41.7	44.1	45.6	48.4	51.2
	30	34.0	35.9	37.9	40.1	42.5	45.0	46.5	49.3	52.2
	40	33.9	36.0	38.0	40.2	42.7	45.2	46.7	49.7	52.6

To correct for wind, enter table with the brakes on speed minus one half the headwind or plus 1.5 times the tailwind.

If ground speed is used for brakes on speed, ignore wind and enter table with sea level, 15°C.

BRAKE COOLING SCHEDULE

Event Adjusted Brake Energy (Millions of Foot Pounds)

REFERENCE BRAKE ENERGY PER BRAKE										
EVENT		10	20	30	40	50	60	70	80	90
LANDING	RTO	10	20	30	40	50	60	70	80	90
	MAX MANUAL	1.4	9.8	18.7	27.6	36.5	45.4	54.5	63.9	73.4
	MAX AUTO	1.4	9.4	17.5	25.6	33.9	42.5	51.4	60.8	70.6
	AUTOBRAKE 4	1.4	9.2	16.8	24.4	32.1	40.0	48.3	56.9	66.2
	AUTOBRAKE 3	1.5	8.9	16.0	23.1	30.2	37.5	45.0	53.0	61.6
	AUTOBRAKE 2	1.7	8.6	15.2	21.7	28.3	35.0	41.9	49.3	57.1
	AUTOBRAKE 1	1.8	8.3	14.6	20.6	26.6	32.7	39.1	45.8	53.0

Cooling Time

COOLING TIME (MINUTES & INDICATION)										
CORRECTED BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)										
	16 & Below	17	18	20	24	28	32	35	36 TO 44	45 & Above
Inflight Gear Down	No Special Procedure Required	1.0	1.3	2.3	4.0	5.3	6.6	7.3	Caution	Fuse Plug Melt zone
Ground		10	13	23	40	53	66	73		
Indication	Up To 2.4	2.4	2.5	2.9	3.4	4.0	4.4	4.9	5.0 – 6.3	6.3 Or Above

Observe maximum quick turnaround limit.

Table does not consider benefit of reverse thrust.

Table shows energy per brake added by a single stop with all brakes operating.

Energy is assumed to be equally distributed among the operating brakes.

Total energy is the sum of residual energy plus energy added.

Add 1.0 million foot pounds for each taxi mile.

For one brake deactivated, increase brake energy by 10%.

For two brakes deactivated, increase brake energy by 20%.

When in caution zone, wheel fuse plugs may melt. Delay takeoff and inspect after one hour. If overheat occurs after takeoff, extend gear soon for at least 8 minutes.

When in fuse plug melt zone, clear runway immediately. Unless required, do not set parking brake. Do not approach gear or attempt to taxi for one hour.

Tire, wheel and brake replacement may be required. If overheat occurs after takeoff, extend gear soon for at least 12 minutes.

Brake temperature indications on EICAS may be used 12 to 15 minutes after airplane has come to a complete stop, or inflight with gear retracted, to determine recommended cooling schedule. (Inflight gear extended, the temperature indication for brakes 2, 4, 10 and 12 may be lower than the temperature indication for brakes 1, 3, 9 and 11 respectively due to airstream effects.)

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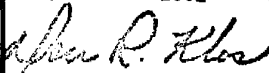
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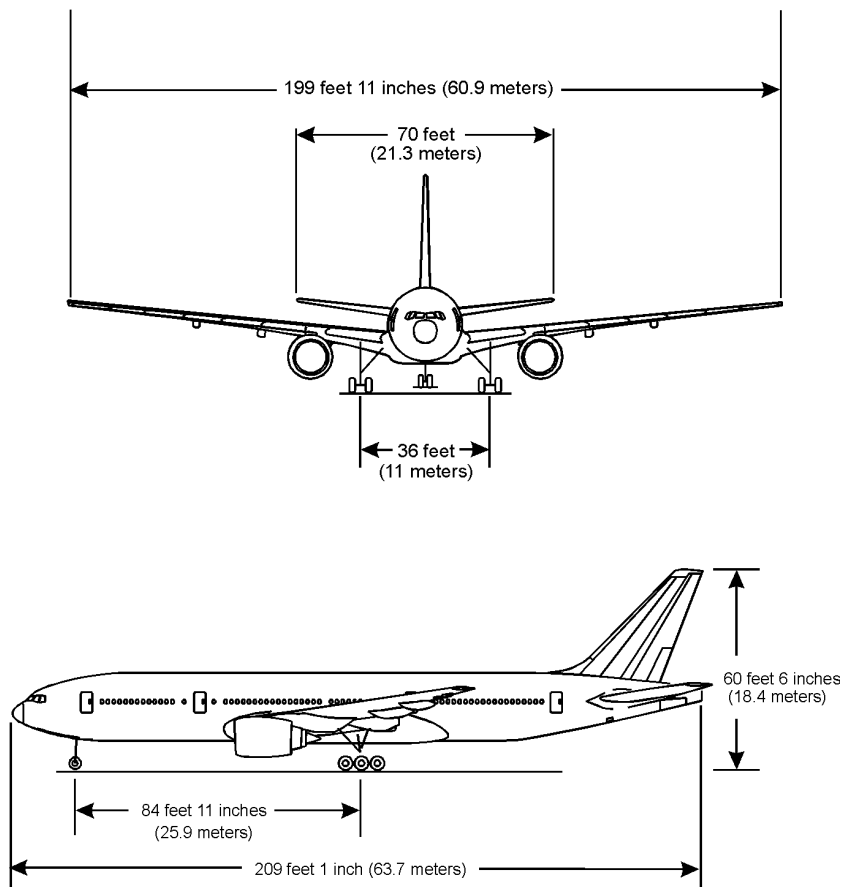
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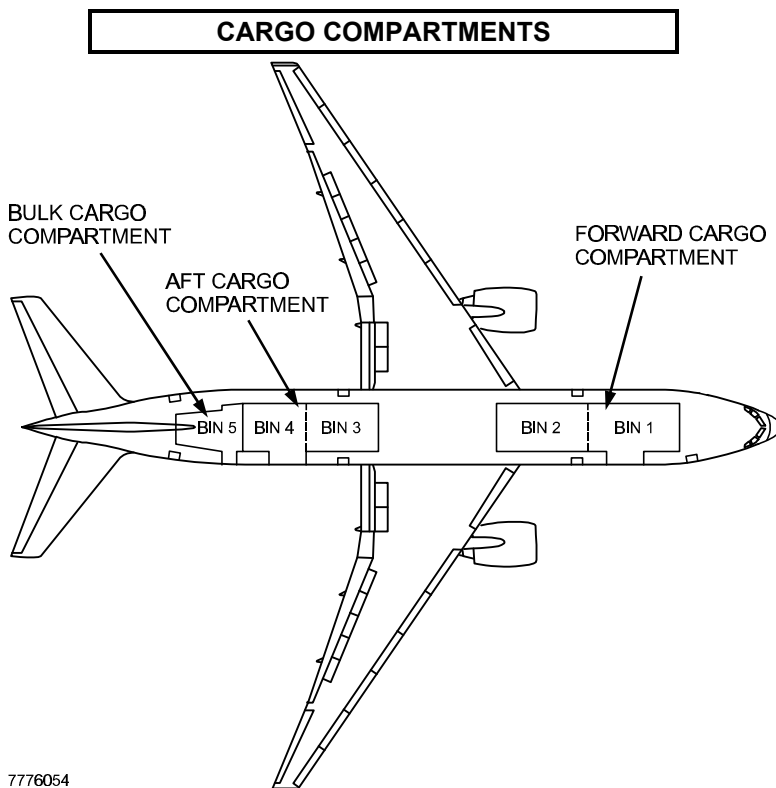
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AIRCRAFT GENERAL

PRINCIPAL DIMENSIONS



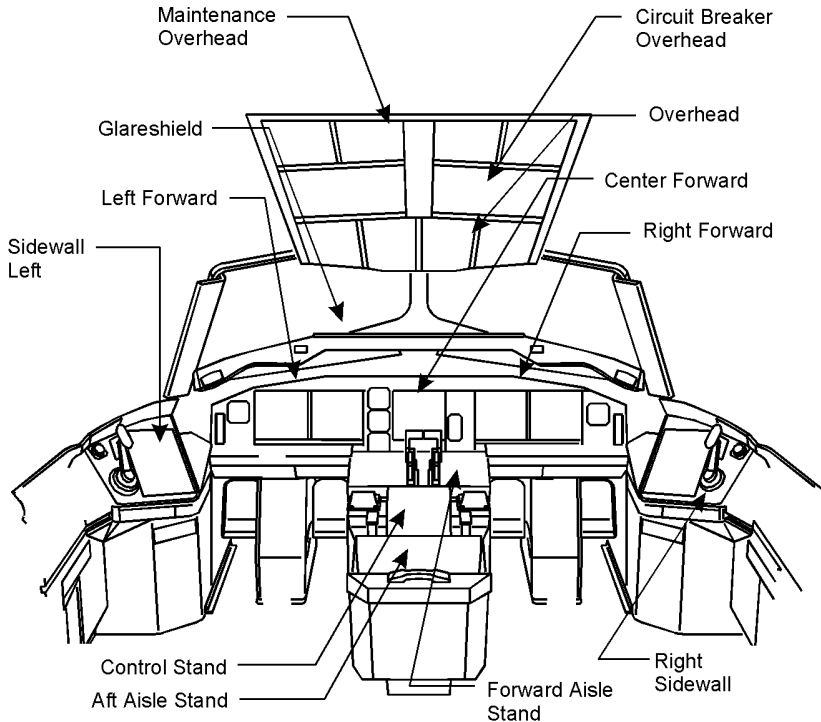
7776001



7776054

The B777 has three cargo compartments; forward, aft and bulk. Each compartment is accessed through its respective door. The aft and bulk cargo compartments are separated only by a curtain.

The cargo compartments are administratively subdivided into five bins. The forward and aft sections of the forward cargo compartment are bin 1 and bin 2 respectively. Bin 3 and bin 4 are the forward and aft sections of the aft cargo compartment, and the bulk compartment is bin 5.

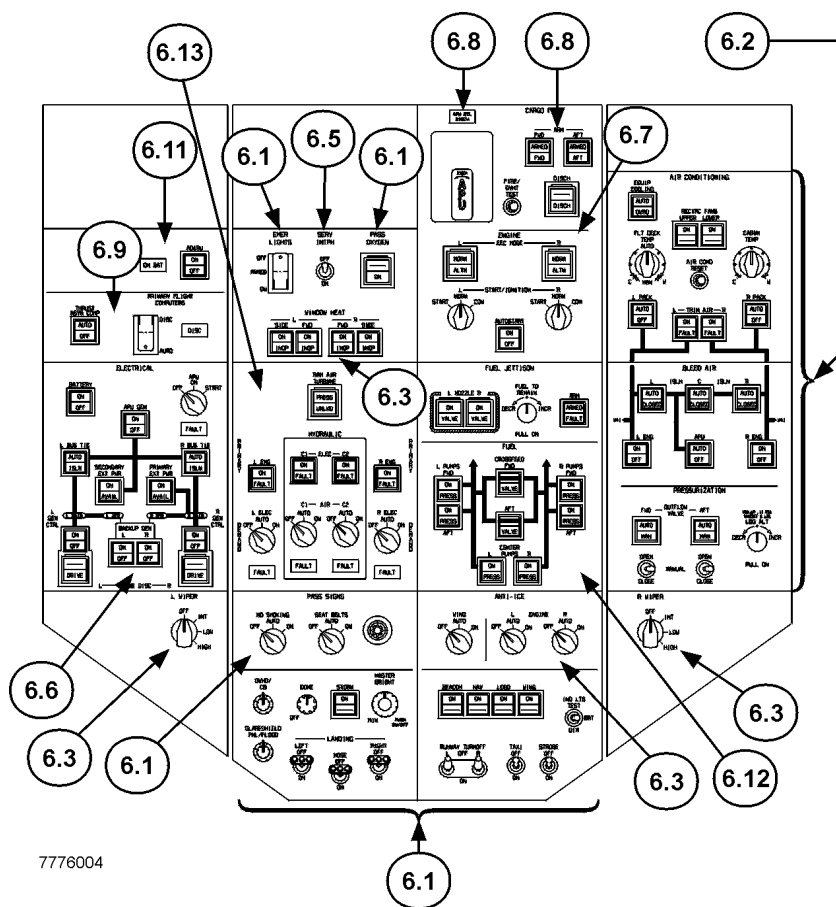
INSTRUMENT PANELS**Flight Deck Panels**

7776003

On the following pages circled numbers refer to sections where information on the item may be found.

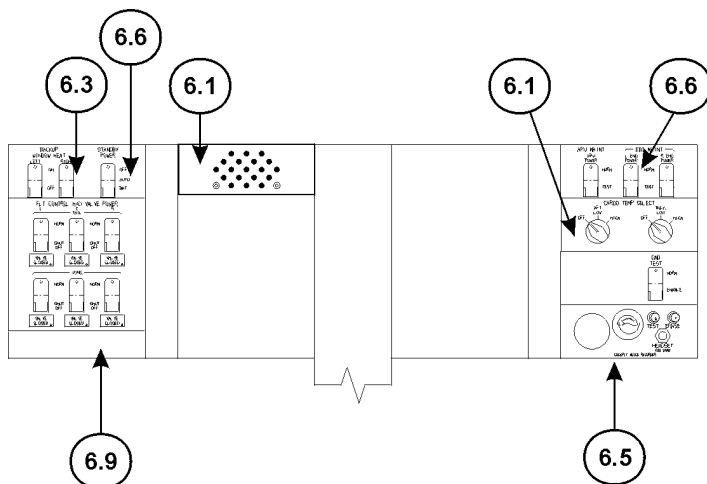
The panels, controls, and indicators shown in this section are representative of installed units and may not exactly match the latest configuration. Refer to the appropriate section system descriptions for current information.

Overhead Panel



7776004

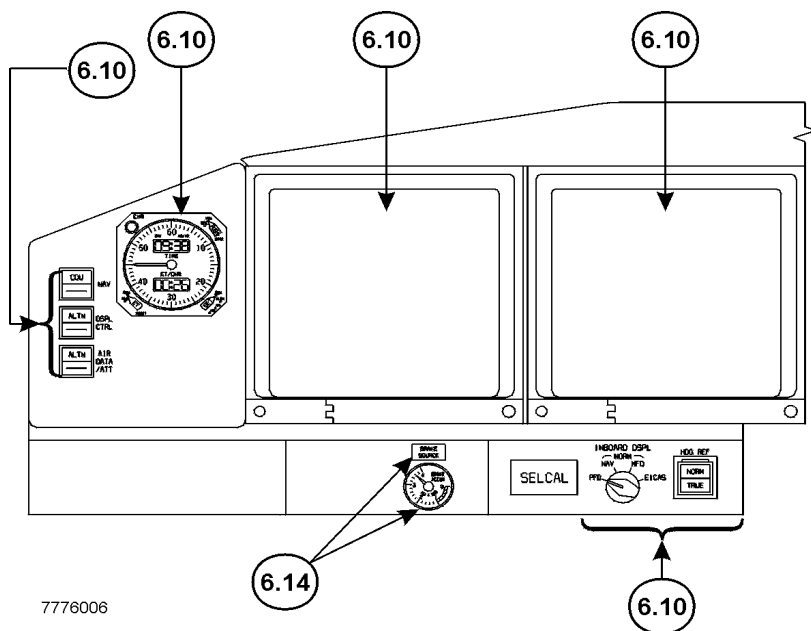
Overhead Maintenance Panel



7776005

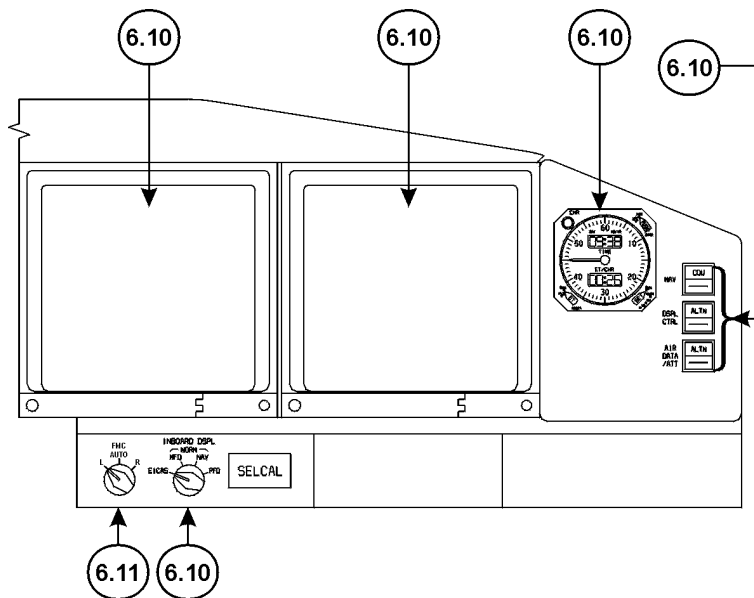
INSTRUMENT PANELS, FORWARD

Left Forward Panel



7776006

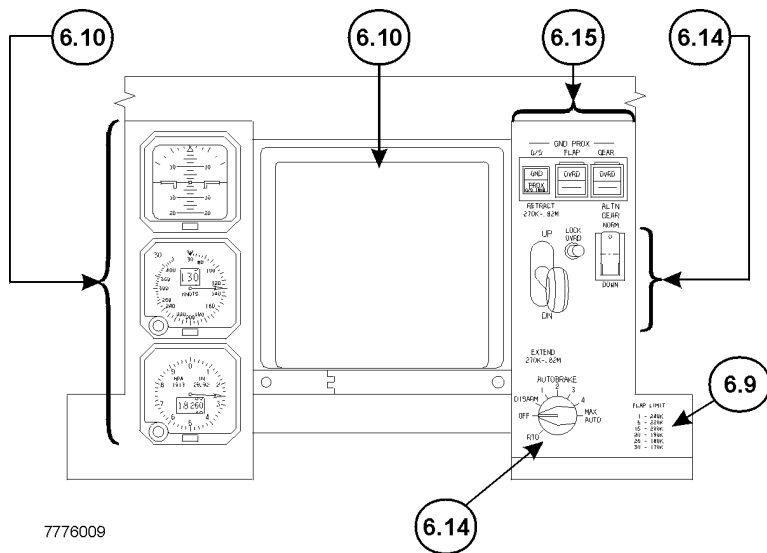
Right Forward Panel



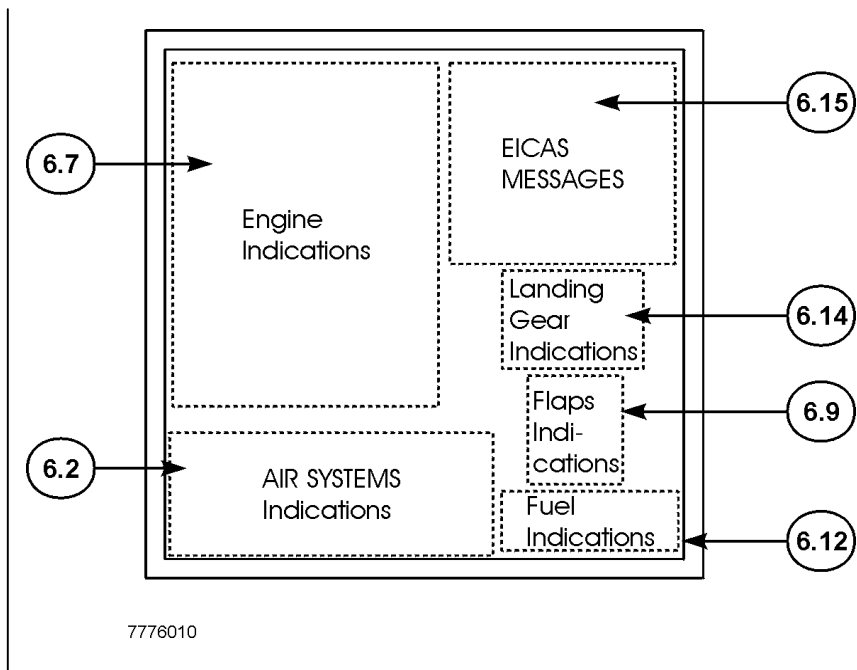
7775007

7776008

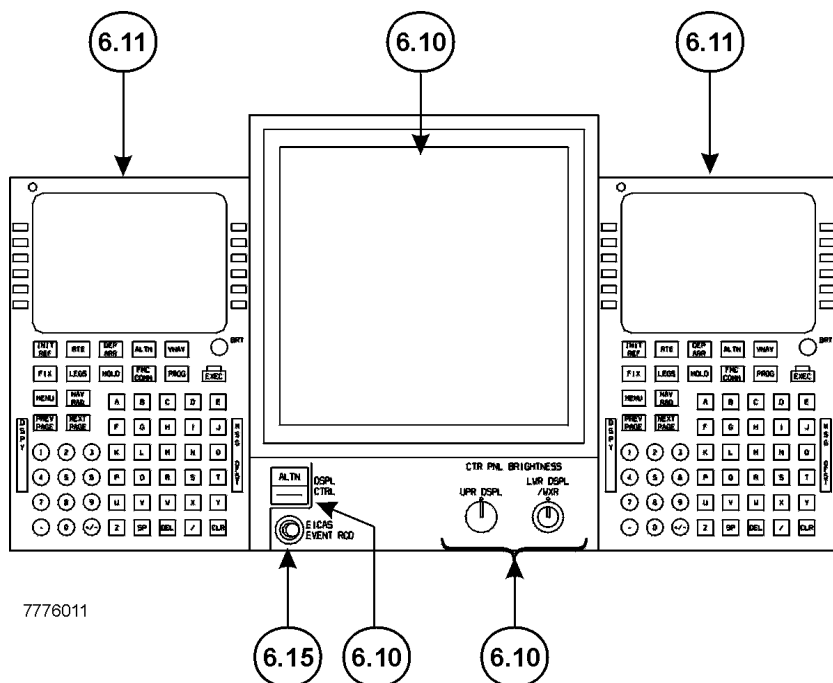
Center Forward Panel



EICAS Display



Forward Aisle Stand



7776011

Multifunction Display

MULTIFUNCTION DISPLAY FORMATS

SECONDARY ENGINE DISPLAY ← (6.7)

STATUS DISPLAY (SHOWN BELOW)

SYNOPTICS:

ELEC ← (6.6)

HYD ← (6.13)

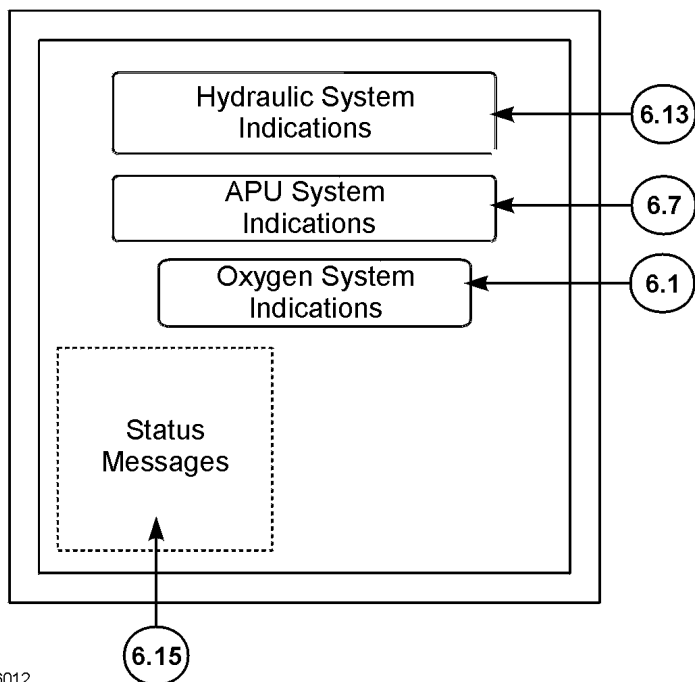
FUEL ← (6.12)

AIR ← (6.2)

DOOR ← (6.1)

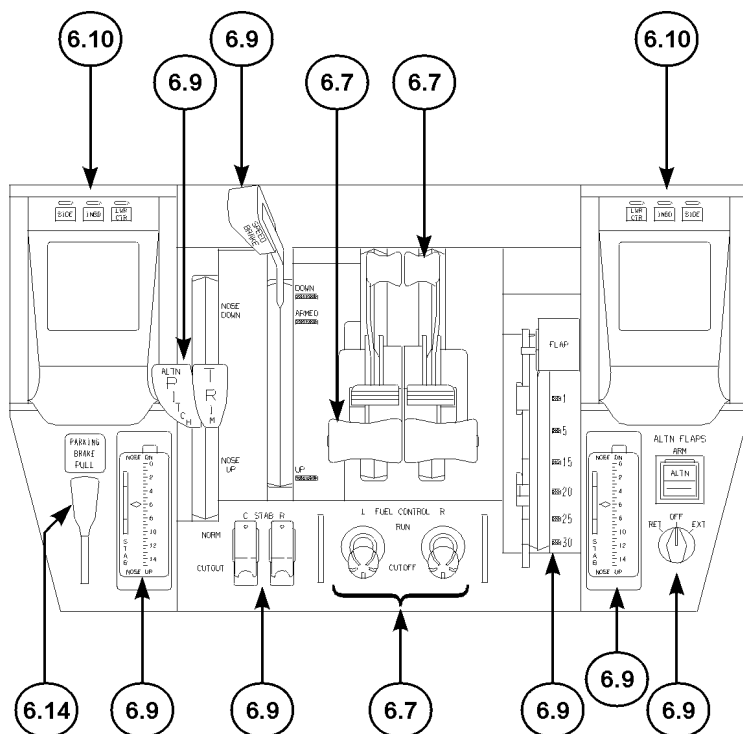
GEAR ← (6.14)

FCTL ← (6.9)



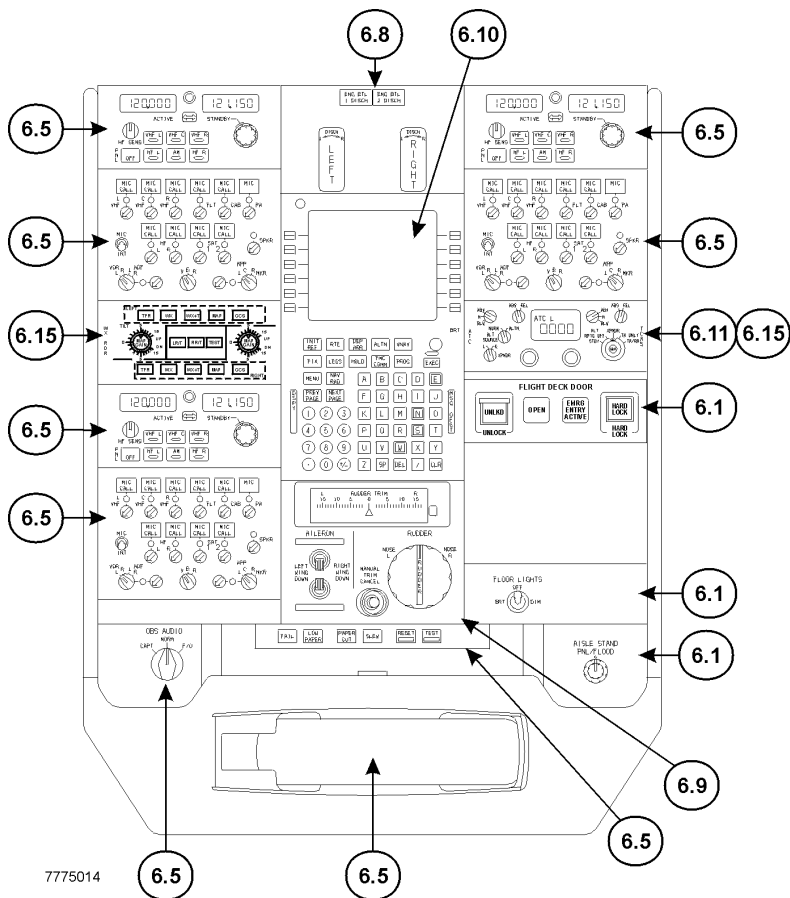
INSTRUMENT PANELS, AFT AND SIDE

Control Stand



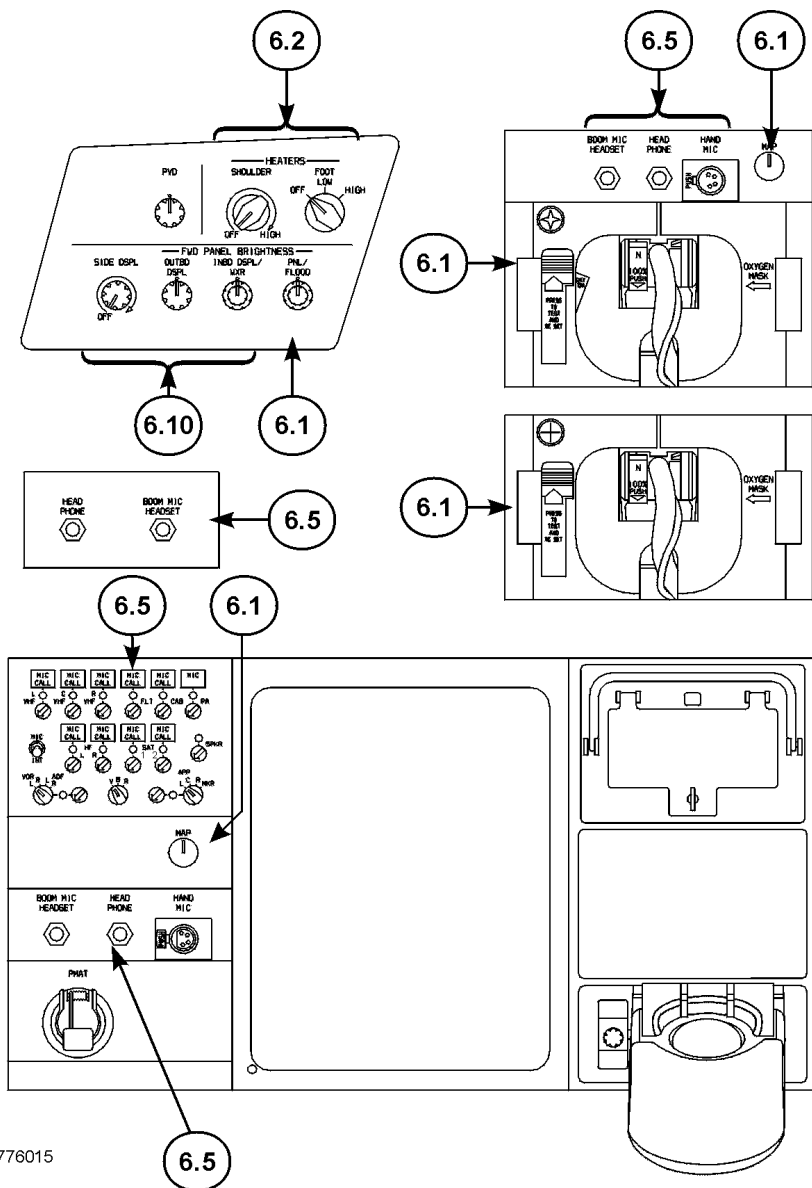
7776013

Aft Aisle Stand



7775014

Left and Right Sidewall, First Observer, and Maintenance Access Terminal/Second Observer Panels



CONTROLS AND INDICATORS**PUSH-BUTTON SWITCHES**

The airplane has two types of push-button switches: alternate action and momentary action. Both types direct crew attention to system status and faults.

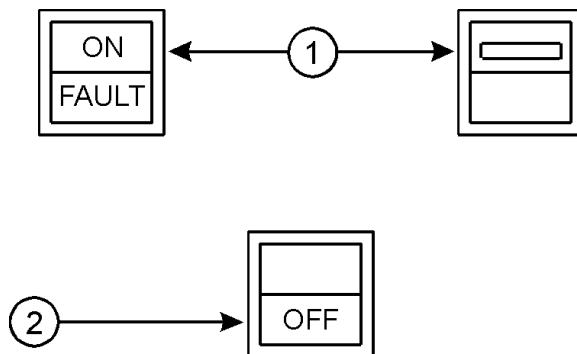
Note: Maintenance personnel should change switch lights. Changing the light requires changing the entire switch cap.

Alternate Action Switches

Alternate action switches have two positions: ON and OFF.

When pushed in and flush with the panel, the switch is ON. The switch indicates the system is on by displaying a word or flow bar.

When pushed out and extended, the switch is OFF. The switch indicates the system is off by not displaying a word or not displaying the flow bar.



7776019

- ① Switch is ON
ON, AUTO, or flow bar visible.

For some switches, system status (**FAULT**, **MAN**, **OFF**, **VALVE**) may be shown in the lower half of the switch.

- ② Switch is OFF
OFF or a line is visible -
- the top of the switch is blank
 - a line indicates no label in this portion of the switch.

Momentary Action Switches

Momentary action switches are spring loaded to the extended position. They are used to activate or deactivate systems or to reset system logic. The switch display indicates system status.



7776053

① Push to Reset

Push - the switch resets the master lights and aural alerts.

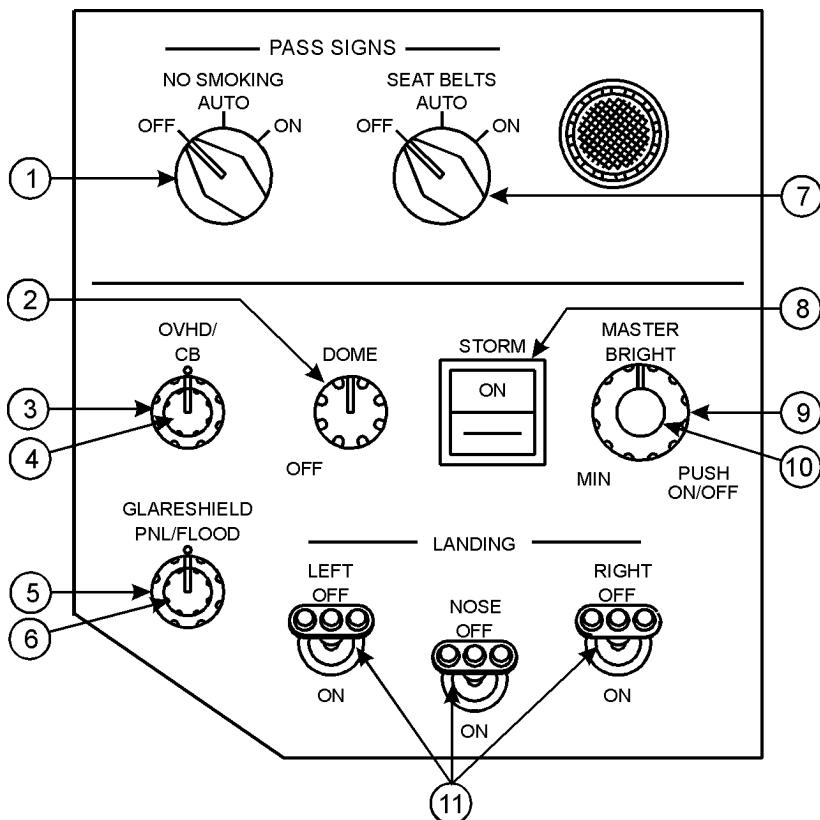
② System Operation

Push - activates or deactivates the system.

INTENTIONALLY LEFT BLANK

PASSENGER SIGNS AND LIGHTING

Overhead Pilot



7776035

① NO SMOKING Selector

OFF / AUTO / ON - The **NO SMOKING** signs are illuminated when power is applied to the aircraft and remain illuminated regardless of switch position.

Note: The switch is left in the OFF position to preclude display of the **NO SMOKING** EICAS MEMO message.

② DOME Light Control

Controls overhead dome light brightness.

③ Overhead (OVHD) Panel Light Control (outer)

Rotate - controls overhead panel light brightness.

④ Circuit Breaker (CB) Panel Light Control (inner)

Rotate - controls circuit breaker panel light brightness.

⑤ GLARESHIELD Panel (PNL) Light Control (outer)

Rotate - controls glareshield panel light brightness.

⑥ GLARESHIELD FLOOD Light Control (inner)

Rotate - controls glareshield flood light brightness.

⑦ SEAT BELTS Selector

OFF - the **FASTEN SEAT BELTS** and **RETURN TO SEAT** signs are not illuminated.

AUTO - the **FASTEN SEAT BELTS** and **RETURN TO SEAT** signs are illuminated or extinguished automatically with reference to airplane altitude and system configuration (refer to the Lighting System Description this section).

ON - the **FASTEN SEAT BELTS** and **RETURN TO SEAT** signs are illuminated.

Note: Any time passenger oxygen is deployed, the **NO SMOKING** and **FASTEN SEAT BELTS** signs illuminate automatically, regardless of the selector position.

⑧ STORM Light Switch

ON - overrides normal controls and illuminates the following lights at maximum brightness:

- All illuminated indicator lights
- Glareshield flood lights
- Instrument panel flood lights
- Aisle stand flood lights
- Dome lights.

9 MASTER BRIGHTNESS Control (outer)

Rotate (when the MASTER BRIGHTNESS switch is pushed on) -

- Controls the brightness of all panel lights and displays (dome lights, flood lights, and circuit breaker panel lights are not controlled by this switch)
- Overrides individual brightness control settings
- Limits adjustment range of individual brightness controls
- Has full adjustment range of all lights when all individual brightness controls are set to the center detent.

10 MASTER BRIGHTNESS Switch

A black ring on the side of the inner switch is visible when the switch is out (**OFF**).

Push ON (in) - The MASTER BRIGHTNESS control is on.

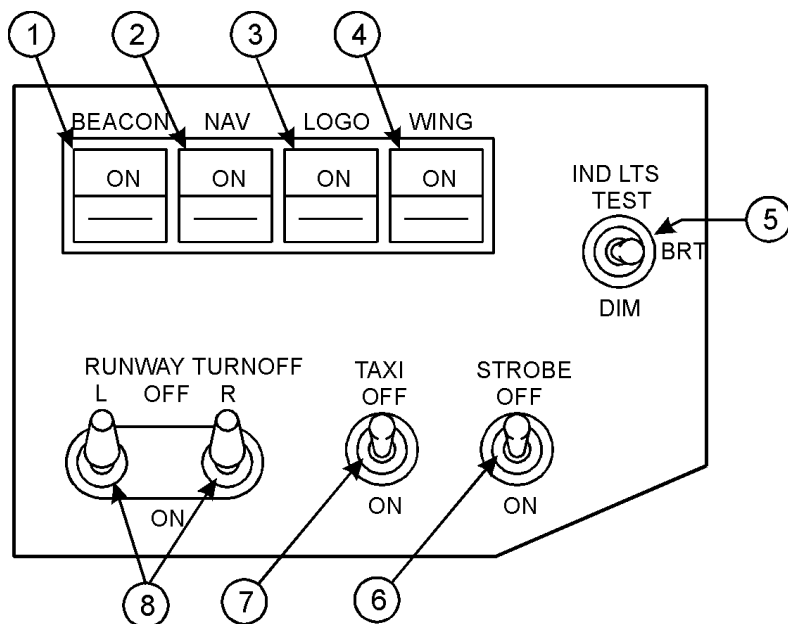
Push OFF (out) - The MASTER BRIGHTNESS control is off.

11 LANDING Light Switches

OFF - The landing light is not illuminated.

ON - The landing light is illuminated.

Note: The nose gear landing lights cannot illuminate when the nose landing gear is not down and locked.

Lighting Panel**OVERHEAD PANEL**

7776036

① BEACON Light Switch

ON - the red anti-collision beacon lights on the top and bottom of the fuselage operate.

② Navigation (NAV) Light Switch

ON - The red, green, and white navigation position lights are illuminated.

③ LOGO Light Switch

ON - The stabilizer-mounted logo lights illuminate the airline logo on the vertical tail surface.

④ WING Light Switch

ON - The wing leading edge illumination lights are illuminated.

⑤ Indicator Lights (IND LTS) Switch

TEST (spring-loaded):

- Illuminates all annunciator lights to full brightness for 10 seconds to check the bulbs, then dims the lights as long as the switch is held
- Causes test patterns to display on the stabilizer position indicators, rudder trim indicator, and radio tuning panel displays.

BRT - sets all illuminated annunciator lights to full brightness.

DIM - sets all illuminated annunciator lights to low brightness.

⑥ STROBE Light Switch

OFF - The white anticollision strobe lights on the tips of each wing and the tail cone are off.

ON - The strobe lights operate.

⑦ TAXI Light Switch

OFF - The taxi lights are extinguished.

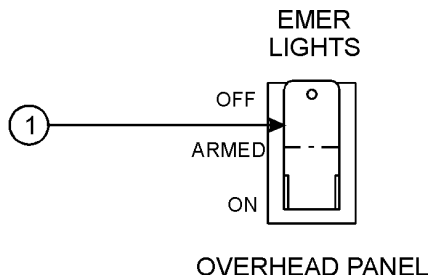
ON - The taxi lights are illuminated.

Note: The taxi lights do not illuminate when the nose landing gear is not down and locked.

⑧ RUNWAY TURNOFF Light Switches

OFF - The runway turnoff light is extinguished.

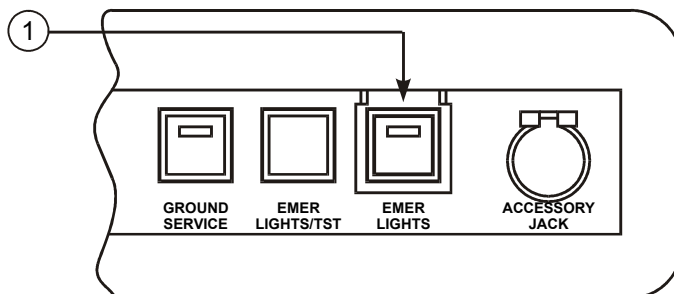
ON - The runway turnoff light is illuminated.

Miscellaneous Lighting Controls**Flight Deck Emergency Lights Switch**

7776038

① Emergency (EMER) LIGHTS Switch

- OFF - Prevents emergency lights system operation if airplane electrical power fails or is turned off.
- ARMED - All emergency lights illuminate automatically if airplane electrical power fails or is turned off.
- ON - All emergency lights illuminate.

Passenger Cabin Emergency Lights Switch

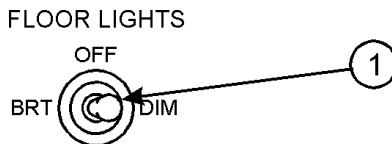
7776039a

① Passenger Cabin Emergency (EMER) LIGHTS Switch

Push -

- Illuminated (red):
- All passenger cabin and exterior emergency lights illuminate
- Bypasses the flight deck emergency lights switch
- Extinguished: All passenger cabin and exterior emergency lights extinguish.

Floor Lights Switch



AFT AISLE STAND

7776040

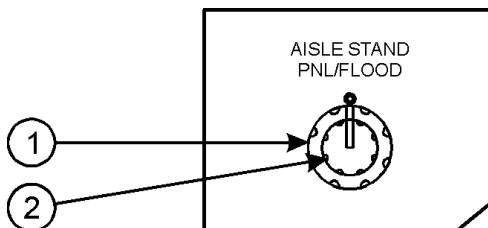
① FLOOR LIGHTS Switch

OFF - The flight deck floor lights are not illuminated.

BRT - The floor lights are illuminated bright.

DIM - The floor lights are illuminated dim.

Aisle Stand Panel/Flood Light Control



7776041

AFT AISLE STAND

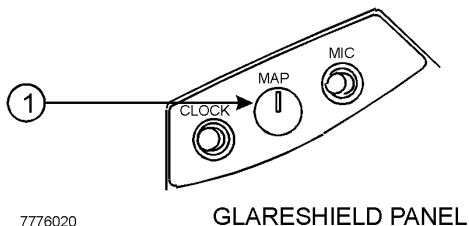
① AISLE STAND Panel (PNL) Light Control (outer)

Rotate - Controls the aisle stand instrument panel light brightness.

② AISLE STAND FLOOD Light Control (inner)

Rotate - Controls the aisle stand flood light brightness.

Map Light Control



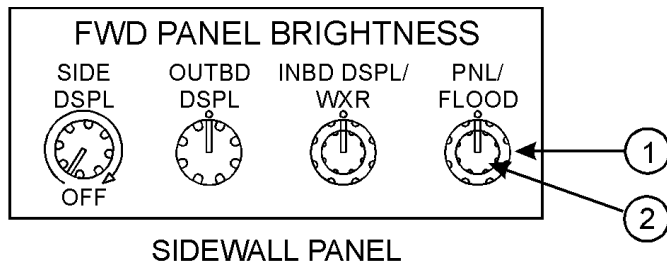
① MAP Light Control

Pull - On

Push - Off

Rotate - Adjusts map light brightness.

Forward Panel Brightness Controls



Note: The display and weather radar brightness controls are described in Section 6.10, Flight Instruments, Displays.

① FORWARD PANEL Light Control (outer)

Rotate - Controls forward panel lights brightness.

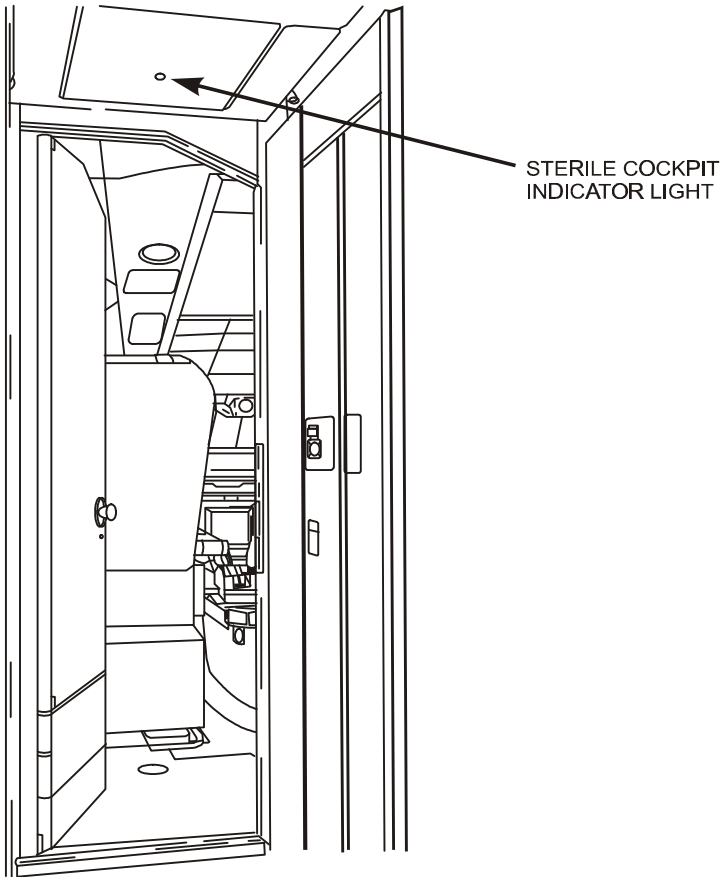
Note: The standby compass light intensity is controlled by the left forward panel light control.

② FORWARD PANEL FLOOD Light Control (inner)

Rotate - Controls forward panel flood light brightness.

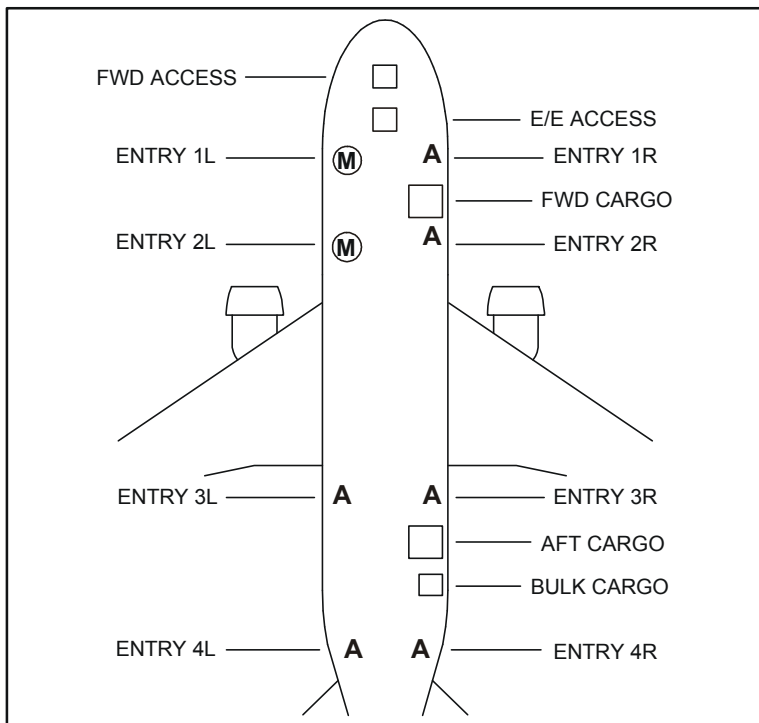
Sterile Cockpit Light

The sterile cockpit light, located in the ceiling aft of the flight deck door, comes on automatically when the aircraft is below 10,000 feet and the parking brake is not set.



DOORS AND WINDOWS

Door Synoptic Display



A (green) – Door mode is armed
 M (white) – Door mode is manual.
 (blank) – Door mode is not available
 A/M can appear inside door symbol.

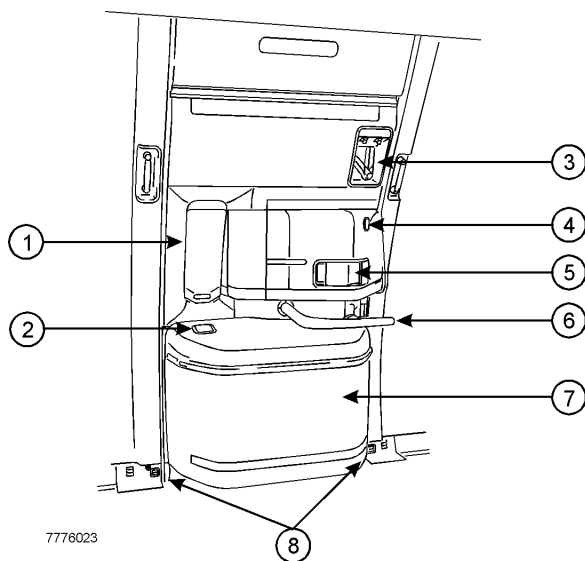
○ (amber) – passenger door open
 (blank) – passenger door closed
 ○ (white) – door status is not available
 □ (amber) – cargo/access door open
 (blank) – cargo/access door closed
 □ (white) – door status is not available

7776022

MULTIFUNCTION DISPLAY

The doors synoptic is displayed by pushing the DOOR synoptic display switch on the display select panel. Display select panel operation is described in Section 6.10, Flight Instruments, Displays.

Passenger Entry Door



① Viewing Window

Allows observation outside the airplane.

② Slide/Raft Gas Bottle Pressure Gauge

If the gauge needle is outside the green zone, the system is unusable.

③ Door Mode Select Panel

See the following graphic.

④ Power Assist Reservoir Pressure Gauge

If the gauge needle is outside the green zone, the system is unusable.

⑤ Gust Lock Release Lever

Grab and pull inward to close the door.

⑥ Door Operating Handle

To open the door - rotate in the direction of the arrow.

To close the door - rotate in the opposite direction of the arrow.

⑦ Slide/Raft

The bustle contains the slide/raft.

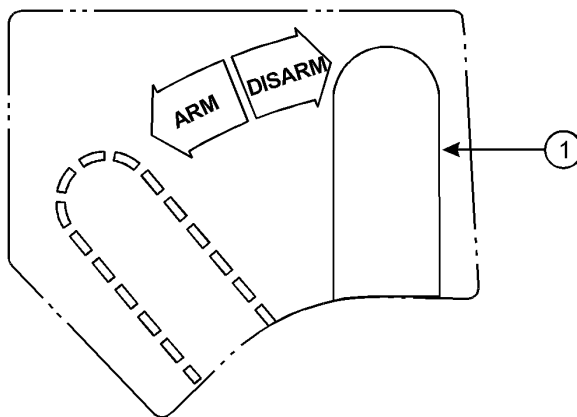
⑧ Girt Bar Indicator Flag Viewing Windows

Yellow in view - door and slide/raft are armed.

Black in view - door and slide/raft are not armed.

Door Mode Select Panel

Note: Outline does not appear on door. Example only.



7776024

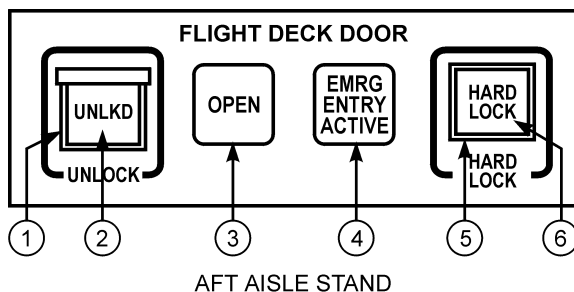
DOOR

① Door Mode Select Lever

ARM - If the door handle is moved to the open position, the door is powered open, and the slide/raft deploys.

Note: If the door is opened from the outside, the mode select lever automatically moves to the disarm position.

DISARM - Power assist door opening and automatic slide/raft deployment are disabled.

Enhanced Flight Deck Door [as installed]**FLIGHT DECK DOOR Control Panel**

7776-102

① UNLOCK Switch

- Electrically unlocks flight deck door while depressed. (Door automatically electrically locks when switch is released and door is fully closed.)
- Disables hard lock mode.

② UNLKD Light (red):

- Illuminated STEADY:
 - Switch is held down and door is unlocked (normal condition).
 - Both solenoids have failed and door is unlocked (non-normal condition).
- Illuminated FLASHING:
 - A fault in the door system or status lights. Security of the door is unknown (non-normal condition).

Note: With the light illuminated for a non-normal condition (STEADY or FLASHING), pushing the HARD LOCK switch extinguishes the light but does not activate the hard lock mode. **This action does not ensure door security, therefore the mechanical lock pin must be engaged.**

③ Door OPEN Status Light (amber)

- Illuminated – Door is not closed against the door jam.

④ EMRG ENTRY ACTIVE Status Light (red)

- Illuminated (flashing) – The cabin mounted FLIGHT DECK DOOR EMERGENCY ENTRANCE switch has been pressed. The status light flashes and “DOOR, DOOR, DOOR” warning message sounds for 30 seconds, or until HARD LOCK or UNLOCK switch is pushed.

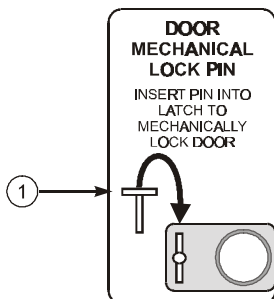
⑤ HARD LOCK Switch

- When pressed (hard lock mode engaged):
 - Illuminates **HARD LOCK** light.
 - Overrides the flight deck door emergency entrance system.
 - Extinguishes flashing **EMERG ENTRY ACTIVE** status light.
 - Stops “DOOR, DOOR, DOOR” warning message.
 - Cancels door emergency entrance unlock function that would occur after 30 seconds, keeping door electrically locked.
 - Inactivates cabin mounted FLIGHT DECK DOOR EMERGENCY ENTRANCE switch.
- System stays in hard locked mode for 30 minutes and then automatically comes out of mode and extinguishes light. 30-minute timer may be reset at any time by pushing the HARD LOCK switch again.
- Hard lock mode may be disabled any time by momentarily turning the flight deck doorknob (do not need to open door), or by pushing the UNLOCK switch.
- If **UNLOCK** light illuminates (indicating a system fault), pressing the HARD LOCK switch:
Will:
 - extinguish light in UNLOCK switch,Will not:
 - engage hard lock mode,
 - illuminate HARD LOCK switch,
 - ensure the door is locked.

⑥ **HARD LOCK** Light (white)

- Illuminated – The flight deck door is in the hard lock mode.

Flight Deck Door Mechanical Lock Pin



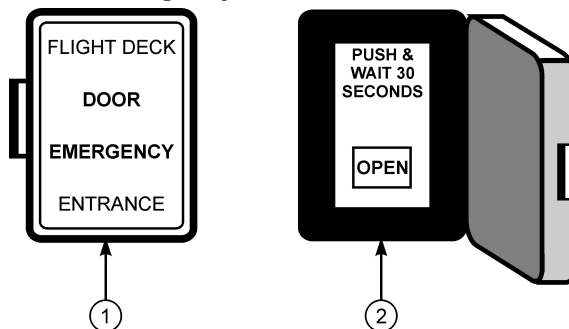
STORED ON INSIDE FLIGHT DECK DOOR

7776-104

① Mechanical Lock Pin

- Instructional placard near doorknob.
- Inserted into hole on door latch to mechanically lock door.
- Serves as redundant lock during a **significant security incident**.
- Does not rely on electrical power.
- Retains depressurization blowout panel functions.
- Retains flight deck emergency exit functions.
- Will not allow door to be opened by FLIGHT DECK DOOR EMERGENCY ENTRANCE system.

Flight Deck Door Emergency Entrance Panel



CABIN MOUNTED PANEL TO LEFT OF DOOR

7776-103

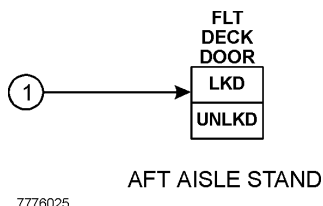
① FLIGHT DECK DOOR EMERGENCY ENTRANCE Panel

② Flight Deck Door Emergency Entrance OPEN Switch

- Illuminates flight deck control panel **EMRG ENTRY ACTIVE** light.
- Activates “DOOR, DOOR, DOOR” warning message. (Sounds for 30 seconds)
 - If flight crew intervenes during the 30 seconds by pushing flight deck control panel **HARD LOCK** switch, warning message stops and emergency entrance system is deactivated for 30 minutes or more as determined by flight crew. The flight crew may, at any time, reset the system by rotating the flight deck doorknob (no need to open door), or by pushing the **UNLOCK** switch.
 - If flight crew does not intervene, the “DOOR, DOOR, DOOR” warning message stops after 30 seconds and the door electrically unlocks for only **5 seconds** to allow access. If the door is not opened within the **5 seconds** it automatically relocks.

Note: If the mechanical lock pin has been engaged, use of the emergency entrance system will not allow the door to be opened.

Flight Deck Door Switch



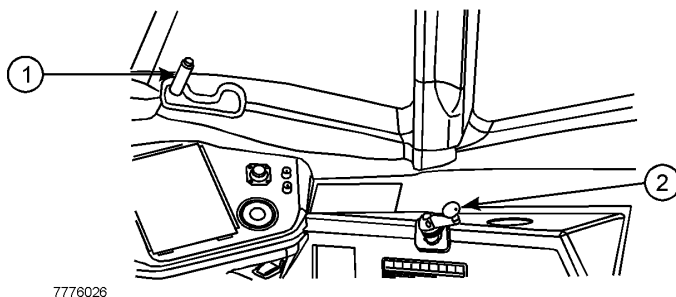
- ① Flight Deck Door Switch
Locked (**LKD**) illuminated:

- The door is locked
- The lock is engaged when the door is closed.

Unlocked (**UNLKD**) illuminated:

- The door is unlocked
- The door remains in the closed position.

Flight Deck Number Two Window



- ① Window Lock Lever

Forward - With the window fully closed, locks the window. If the lock lever is properly locked, the orange indicator is not visible below the release button. The EICAS message **WINDOW FLT DECK L, R** displays if a window is not properly latched.

Aft - Unlocks the window so it can be cranked open.

- ② Window Crank

Used to position the window open or closed when the window lock lever is unlocked.

To reposition the window crank without moving the window, push and hold the button in the center of the window crank.

OXYGEN SYSTEMS

Oxygen Indications



MULTIFUNCTION DISPLAY

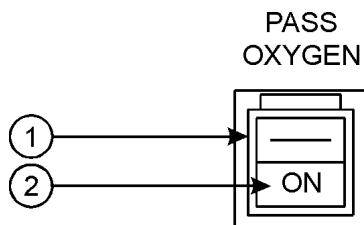
7776027

① Oxygen Pressure Display

Displays crew oxygen cylinder pressure (PSI).

Note: Access is through the display select panel STATUS switch.

Passenger Oxygen Switch



OVERHEAD PANEL

7776029

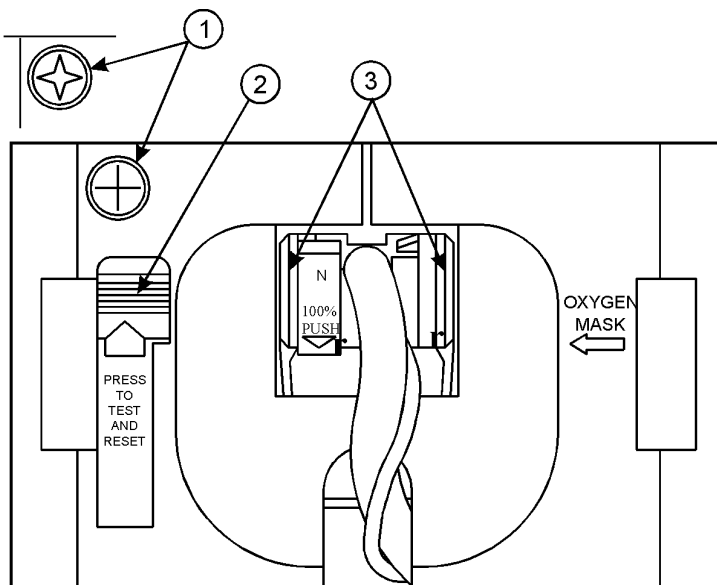
① PASSENGER OXYGEN Switch

Push - The passenger cabin oxygen masks drop.

② Passenger Oxygen ON Light

Illuminated (amber) - The passenger oxygen system is operating and the masks have dropped.

Oxygen Mask Panel



CREWMEMBER
STATION (1 each)

7776032

① Oxygen Flow Indicator

Shows a yellow cross when oxygen is flowing.

② RESET/TEST Switch

Push -

- With the left oxygen panel door closed and the OXY ON not displayed, turns oxygen on momentarily to test the regulator.
- With the left oxygen panel door closed and the OXY ON flag displayed, turns oxygen off and deactivates the mask microphone, reactivates the boom microphone.

③ Oxygen Mask Release Levers

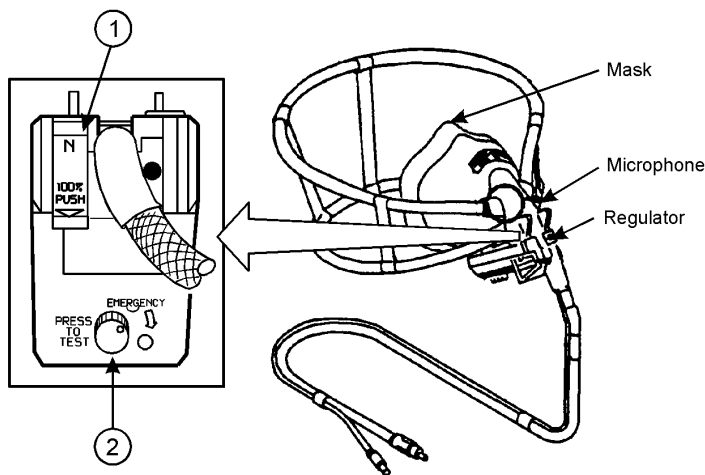
Squeeze and pull -

- Unlocks the oxygen panel doors
- Releases the mask
- Oxygen turns on when the oxygen panel doors open
- Automatically selects the mask microphone when the left oxygen panel door is opened
- Disables the boom microphone.

Squeeze (right lever) - inflates the mask harness.

Release - deflates the mask harness into position on the head and face.

Oxygen Mask and Regulator



7776033a

CREWMEMBER STATION (1 each)

① NORMAL/100% Switch

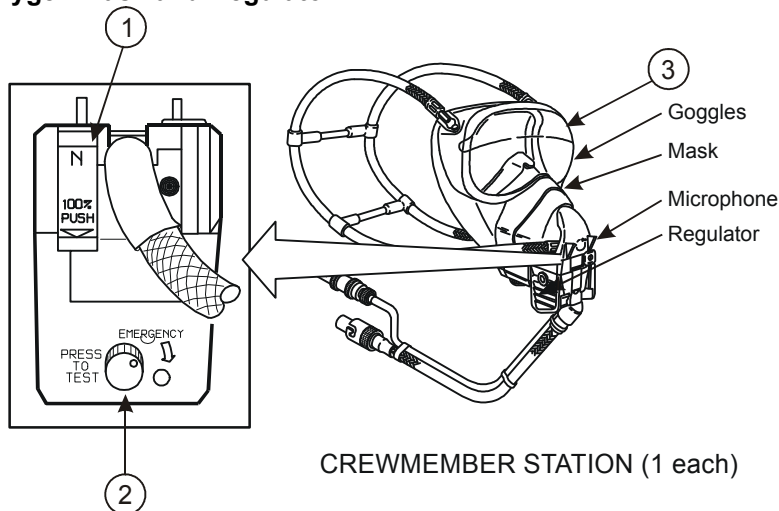
N - Supplies an air/oxygen mixture on demand (the ratio depends on cabin altitude).

100% - Supplies 100% oxygen on demand (not an air/oxygen mixture).

② Normal (non-emergency) position – Supplies air / oxygen mixture or 100% oxygen on demand, depending upon the position of the Normal / 100% switch. Automatically supplies 100% oxygen under positive pressure when cabin altitude is above a preset value.

EMERGENCY position (rotate in the direction of the arrow) - Supplies 100% oxygen under positive pressure at all cabin altitudes (protects against smoke and harmful vapors).

PRESS TO TEST- Tests the positive pressure supply to the regulator signal.

Oxygen Mask and Regulator

7776033

① NORMAL/100% Switch

N - Supplies an air/oxygen mixture on demand (the ratio depends on cabin altitude).

100% - Supplies 100% oxygen on demand (not an air/oxygen mixture).

② Oxygen Mask Emergency/Test Selector

Normal (non-emergency) position – Supplies air / oxygen mixture or 100% oxygen on demand, depending upon the position of the Normal / 100% switch. Automatically supplies 100% oxygen under positive pressure when cabin altitude is above a preset value.

EMERGENCY position (rotate in the direction of the arrow) - Supplies 100% oxygen under positive pressure at all cabin altitudes (protects against smoke and harmful vapors).

PRESS TO TEST- Tests the positive pressure supply to the regulator signal.

③ Protective Strip

There is a protective strip of clear plastic on the top portion of the lens. This strip can be peeled off using the tab on the right side in case of icing caused by a rapid depressurization.

EMERGENCY EQUIPMENT, DOORS, AND WINDOWS
--

Systems Introduction

This section describes miscellaneous airplane systems, including:

- Lighting Systems
- Oxygen Systems
- Emergency Equipment
- Doors and Windows
- Flight Deck Seats.

LIGHTING SYSTEMS

Lighting systems described in this chapter include:

- Exterior Lighting
- Flight Deck Lighting
- Passenger Cabin Lighting
- Emergency Lighting.

Exterior Lighting

Exterior lighting consists of these lights:

- Landing
- Runway Turnoff
- Taxi
- Strobe
- Beacon
- Navigation (position)
- Logo
- Wing Leading Edge Illumination
- Escape Slide Emergency Lights.

Landing Lights

The landing lights consist of the left, right, and nose gear landing lights. The left and right landing lights are located in the left and right wing root. These lights are optimized for flare and ground roll. The two nose gear-located landing lights are optimized for approach.

Runway Turnoff Lights

Runway turnoff lights are installed in the left and right wing roots. The lights illuminate the area in front of the main gear.

Taxi Lights

Taxi lights are installed on the non-steerable portion of the nose strut. They are inoperative when the nose landing gear is not down and locked.

Strobe Lights

The strobe lights are white anti-collision strobe lights located on each forward wing tip and on the tail cone.

Beacon Lights

The beacon lights are red anti-collision strobe lights located on the top and bottom of the fuselage.

Navigation Lights

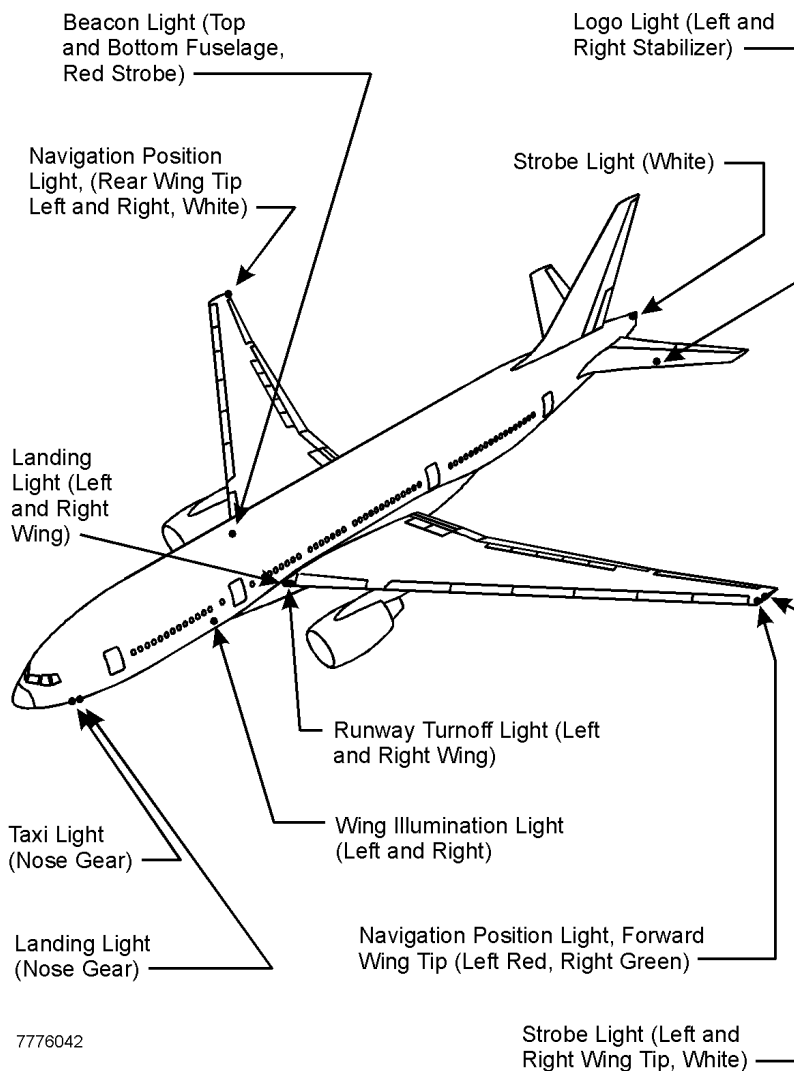
The navigation lights are the standard red (left forward wingtip), green (right forward wingtip), and white (aft tip of both wings) position lights.

Logo Lights

Logo lights are located on the stabilizer to illuminate the airline logo on the vertical tail surface.

Wing Lights

Wing lights are installed on the fuselage and illuminate the leading edge of the wing.

Exterior Lighting Locations

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Flight Deck Lighting

Flight deck lighting is provided for panel illumination, area lighting and localized illumination. Flood lights and light plates provide panel illumination. Dome lights provide flight deck area lighting. Map lights and a single utility light provide localized illumination.

Panel and flood lights illuminate the forward panels, glareshield and aisle stand panels. When the storm light switch is on, the left and right forward panel flood lights, glareshield flood lights, dome lights, aisle stand flood light, and all illuminated annunciator lights illuminate at full brightness.

If normal electrical power is lost, standby electrical power is automatically provided to the primary displays. The aisle stand, left and right forward panel and glareshield flood lights, and the dome lights illuminate automatically at a fixed brightness.

Master Brightness Control System

The MASTER BRIGHTNESS control provides the means of controlling panel and display lighting brightness with the use of one control. The control is turned on when the MASTER BRIGHTNESS switch is pushed ON.

Lighting controlled through the MASTER BRIGHTNESS system are:

- PFDs
- MFDs
- EICAS
- CDUs
- Clocks
- Standby Instruments
- Standby Compass
- Digital Displays
- Overhead Panel
- Glareshield Panel
- Forward Panels (left, center, and right)
- Side Panel Displays
- Aisle Stand Panels (forward and aft).

The individual lighting controls for the above displays and panels all have a center DETENT position identified by a white dot at the mid-range adjustment position.

Individual controls can be used for dimming individual displays and panels. The individual controls have limited adjustment capability when the MASTER BRIGHTNESS switch is ON, and should be centered in the DETENT when first adjusting the MASTER BRIGHTNESS control. They have full range of brightness control when the MASTER BRIGHTNESS switch is OFF.

Passenger Cabin Lighting

Passenger cabin lighting near the flight deck entry door is automatically dimmed or extinguished when the flight deck door is opened while an engine is operating. This reduces the light level entering the flight deck at night.

Passenger Cabin Signs

The passenger cabin signs are controlled by overhead panel selectors. The passenger signs illuminate when the following conditions are satisfied:

FASTEN SEAT BELTS signs (AUTO selected):

- Landing gear not up and locked, or
- Flap lever not up, or
- Airplane altitude below an airline defined altitude, or
- Cabin altitude above 10,000 feet, or
- Passenger oxygen on.

NO SMOKING signs always on (CAL option):

All passenger signs can be controlled manually by positioning the respective switch to ON or OFF. When the **FASTEN SEAT BELTS** and **NO SMOKING** selectors are in the OFF position, and oxygen is ON, the **FASTEN SEAT BELTS** and **NO SMOKING** signs illuminate.

RETURN TO SEAT signs are illuminated with the **FASTEN SEAT BELTS** signs, except when oxygen is deployed.

When the passenger cabin signs illuminate or extinguish, a low tone sounds over the PA system.

Emergency Lighting

Emergency lighting is controlled by the EMERGENCY LIGHTS switch on the overhead panel. The switch can be used to manually activate or arm the system for automatic operation. Automatic operation occurs if DC power fails or is turned off when the system is armed. The emergency lighting system can also be controlled by the EMERGENCY LIGHTS switch on the main flight attendant switch panel.

When the EMERGENCY LIGHTS switch in the flight deck is armed, and the door mode select lever is in the armed position, moving the door handle to the open position will cause the exterior fuselage light and the interior emergency lights at that door to illuminate.

The emergency lighting system is powered by remote batteries. Battery charge is maintained by the airplane electrical system. A fully charged battery provides at least 15 minutes of operation.

The EICAS advisory message **EMER LIGHTS** is displayed if:

- The emergency lights switch is not in the ARMED position, or
- The emergency lights switch is in the ARMED position, and the emergency lights are activated by the switch at a flight attendant panel.

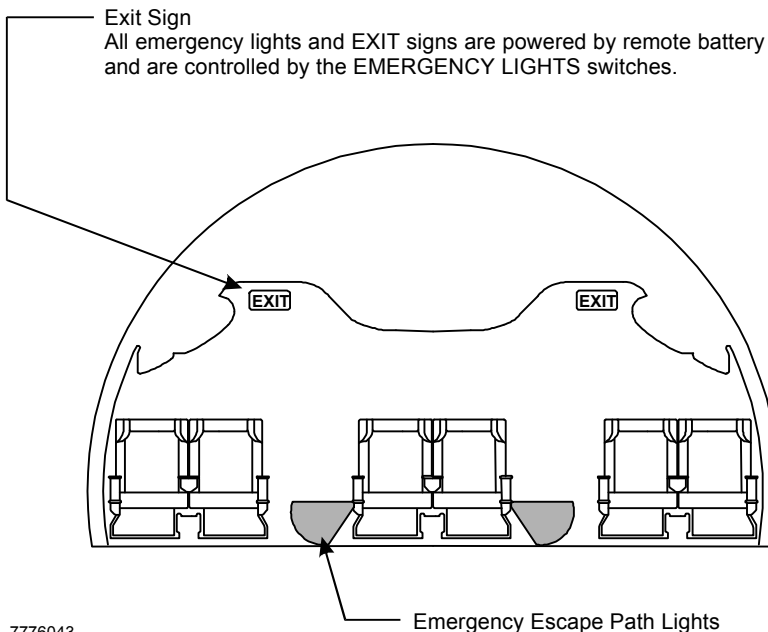
Interior Emergency Lighting

Interior emergency lighting consists of door, aisle, cross-aisle, escape path, exit lights, and luminescent exit signs.

Escape path lighting consists of lights installed in the arm rest of the center passenger seats, and on center galleys, lavatories, closets and partitions spaced at intervals in the aisles and cross-aisles. When illuminated, escape path lighting provides visual guidance for emergency evacuation if all sources of lighting more than four feet above the aisle floor are obscured by smoke.

Battery powered exit lights are located at each cabin exit.

Interior Emergency Lighting Locations



Exterior Emergency Lighting

Exterior emergency lights are located aft of each door and illuminate the slide area. Lights are also installed in each slide to illuminate the ground at the end of the slide and to help illuminate the door 2 sliding surface.

OXYGEN SYSTEMS

Two independent oxygen systems are provided, one for the flight crew and one for the passengers. Portable oxygen cylinders are located throughout the airplane for emergency use. Two oxygen bottles are located in the lower equipment bay for crew use.

Flight Crew Oxygen System

The flight crew oxygen system uses quick-donning masks and regulators located at each crew station. Oxygen pressure is displayed on the MFD status display.

The EICAS advisory message **CREW OXYGEN LOW** alerts the flight crew of a low oxygen pressure condition.

Flight crew and observer masks and regulators are installed in oxygen mask panels near each seat. Squeezing the red oxygen mask release levers releases the mask from stowage. Removing the mask:

- Inflates the mask harness
- Momentarily displays the yellow oxygen flow indicator
- Selects the mask microphone in the removed mask (the boom microphone is deselected).

The boom microphone can be reselected by closing the left oxygen panel door and pushing and releasing the reset/test switch. This also shuts off oxygen to the mask. The oxygen flow can be restored by opening the left oxygen panel door.

Crew Oxygen Mask Microphone Test

The oxygen mask microphone can be tested without removing it from the storage box.

- Select the flight interphone transmitter and set the speaker volume as desired.
- Push and hold a MIC switch on either the audio control panel or the glare shield.
- Push both the oxygen mask RESET/TEST switch and EMERGENCY/TEST selector.

The sound of oxygen flowing is heard through the speaker, verifying microphone operation.

Passenger Oxygen System

The passenger oxygen system is supplied by individual chemical oxygen generators. The oxygen system provides oxygen to the passenger, attendant stations, and lavatory service units. The chemical oxygen generators provide oxygen for approximately 22 minutes. The passenger oxygen masks and chemical oxygen generators are located above the passenger seats in passenger service units (PSUs). Oxygen flows from a PSU generator when any mask hanging from that PSU is pulled. The masks automatically drop from the PSUs if cabin altitude exceeds approximately 13,500 feet. The passenger masks can be manually deployed from the flight deck by pushing the overhead panel PASSENGER OXYGEN switch to the ON position.

Portable Oxygen Bottles

Portable oxygen bottles are stowed in various locations in the passenger cabin. The bottles are fitted with disposable masks and are used for first aid purposes or as walk-around units. All bottles are identical in size and capacity.

EMERGENCY EQUIPMENT

Item Name	Diagram Abbreviation	# on board / # req'd	Where enter discrepancies
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- Where is it located?
- What are the preflight inspection requirements?
- Who may use it?
- Directions for use or additional information?

Automatic External Defibrillator	AED	1/0	MX Log
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- Locked container in the aft-most usable overhead bin, aircraft left.
- May be used by medical personnel, trained flight attendant, or flight attendant who has not been trained but is comfortable using the A.E.D.
- For preflight inspection and operational instructions see First Aid section of CAL Inflight Manual.

Attendant Life Vest	ALV	14/14	MX Log
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- Stowed at each crew member station.
- Vests are red and fluorescent in color.
- Insure presence of vest.
- May be used by any flight attendant or passenger.
- Hold vest so the word “top” is up.
- Place vest over head and place arms through straps on sides between bladders.
- Grasp straps under arms, lean forward and pull straps down sharply until back panel is fully extended.
- Pull outward on the yellow tabs to tighten straps snugly to waist.
- Inflate vest just prior to exiting the aircraft by pulling down sharply on the two red tabs on the front of the vest. If vest fails to inflate, it may be orally inflated by blowing into the tubes located at shoulder level.
- A rescue light located on the shoulder is battery / water activated.
- Remove the “Pull To Light” tab at waist level (for night ditching only).

CPR Resuscitators	CPR	14/0	Cabin Log
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- Located one at each F/A jump seat.
- Insert the “Patient” end of the white rectangular universal airway into the customer’s mouth and position the flat side over the tongue.
- Connect the isolation valve with the blue arrows to the airtube of the SealEasy mask. The blue arrows should be pointing toward the SealEasy mask.
- Slip the SealEasy mask, with the airtube pointing up, over the universal airway. The universal airway should be inserted into the tube of the mask in this position, with the soft side of the SealEasy mask covering the customers’ mouth and nose.

Crash Axe	AX	1/1	MX Log
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- Located in Flight Deck.
- Pick end used for puncturing or tearing.
- Blunt end used for chopping or cutting.

Crew Life Vest	CLV	4/4	MX Log
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- Located at each Flight Deck seat.
- Crew vests are red or fluorescent orange in color.
- Procedures are identical to those for the Attendant Life Vest.

Emergency Flashlight	EFL	15/11	MX Log
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- One located in Flight Deck, and one at each F/A jump seat.
- Removing flashlight from bracket automatically activates.
- Duration is approximately 4 – 5 hours.

Emergency Light Switch	ELS	1/1	MX Log
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- ELS in the cabin can override the Flight Deck switch, when in the OFF or ARMED position.
- Use by crew only.

Emergency Locator Transmitter	ELT	2/1	MX Log
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- ELT’s are an integral part of the slide / rafts at doors 1L and 4R.
- Automatically activated upon deployment of slide raft.
- May be manually activated by pulling pin at transmitter base and touching contacts with damp finger.
- Frequencies that are used are VHF 121.50, UHF 243.0 and in the future HF 406 will be added.

Escape Ropes	ER	2/2	MX Log
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- Stowed in compartments above the pilot seats.
- Attached to the airplane structure above both number two flight deck windows.

Fire Extinguishers (Halon)	HL	4/3	MX Log
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- Preflight – Gauge in green zone and pin in place.
- Used on electrical, fuel and grease fires (Class A, B, C).
- Pull ring pin.
- Hold upright.
- Aim at base of fire with side of body towards fire.
- Squeeze lever downward.
- Spray at base of fire in a side to side motion.
- Duration – 8 sec. Continuous, 25 sec. Intermittent.
- If used on Class A, back up with H2O extinguisher.

Fire Extinguishers Lavatory	FEL	See below	MX Log
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- Preflight – Temperature dots are white in color (if dots are black in color, notify Captain immediately).
- Operate automatically when fire sensed in lavatory trash can.
- One (1) each lavatory. May be inoperative provided the associated lavatory smoke detection system operates normally. If not then the following must be done.
 - (a) Lavatory waste receptacle is empty.
 - (b) Lavatory door is locked closed and placarded, INOPERATIVE – DO NOT ENTER, and
 - (c) Lavatory is not used for any purpose.

Fire Extinguishers (Water)	H2O	3/3	MX Log
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- Preflight – Check wire seal on handle.
- Ensure CO2 cartridge is present by looking through the hole in the extinguisher handle.
- Rotate handle fully clockwise.
- Hold upright.
- Aim at base of fire with side of body towards fire.
- Depress lever on top.
- Use a sweeping motion.
- Duration – 30 – 45 sec.
- Used on paper, rubber and wood fires (Class A).

Fire Gloves	FG	1/1	MX Log
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- Insert left hand in left glove and right hand in right glove.
- To be used when fighting fires.
- Located in Flight Deck.

First Aid Kit	FAK	5/4	MX Log
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- Located in cabin, all kits should be sealed with shrink-wrap.
- Flight Attendants will notify the Flight Deck if any kit has been opened.

Handcuffs	HC	2/0	MX Log
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- Located in locking container in last overhead bin, aircraft left.
- Two clear plastic bags containing three sets of plastic handcuffs, cutting tool for removing, instructions for operating, and checklist for use and follow-up procedures.
- Use only under direction of Captain.
- Captain's Irregularity Report required when used.

Megaphone	MEG	2/2	MX Log
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- Located outboard stowage fwd. galley, outboard stowage aft galley.
- Three types: Blue, Orange and Red.
- Grip handle and hold close to mouth.
- Depress handle or trigger and speak into the mouthpiece.
- To activate siren, pull small pin out of side of megaphone (orange type only).

Medical Kit	MK/EEMK	1/1	MX Log
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- Flight Deck, behind F/O on right side of bulkhead.
- Insure kit is secure with unopened wrapping.
- May be used by any medical personnel or as required at Captain's discretion.
- Should be inventoried if used and replacement not available.
- In the near future, the **Enhanced Emergency Medical Kit** will be installed and located in the same locked container as the AED in the aft most useable overhead bin aircraft left. This will cause the removal of the present Medical Kit from the Flight Deck.
- EEMK Preflight is done by F/A's.
- EEMK is to be used by **licensed Medical Doctor (MD), or Doctor of Osteopathy (DO), nurses, or paramedic / emergency medical technicians (EMT)**.
- The F/A will inform the Captain when the kit is used, and the **Captain will complete a Captain's Irregularity Report and make an entry in the aircraft logbook.**

Polar Exposure Suits	PXS	1/1	MX Log
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- Located in compartment above door 1 right placarded CREW USE ONLY.
- Use Flight Deck key to open after placard is removed and wear in severe cold temperature conditions when necessary for crew member to perform duties outside of aircraft.
- One (1) kit containing two (2) suites.

Protective Breathing Equipment	PBE	6/5	MX Log
<ul style="list-style-type: none"> • Located (1) one each Flight Deck, fwd outboard stowage, fwd outboard galley, center floor mounted stowage, aft galley outboard stowage right, and stowage left. • Preflight: Ensure that hood packet is enclosed and vacuum-seal intact. • Remove vacuum-sealed pouch from white plastic box. • Tear open pouch and don the hood. • Pull adjustment straps forward to activate, then back to secure the hood. • Initial generated oxygen inflates hood, providing breathable atmosphere. • Pull straps again if activation fails. • Stick fingers under the neck seal to allow lung inhalation. • Excessive leakage of oral / nasal cone or neck seal may result in excess build up of carbon dioxide. Don an alternate hood. • Place hood away from heat and/or flames. • After removing hood, do not expose yourself to flames. • Run fingers through your hair to remove oxygen • Use by crew only. 			

Portable Oxygen Bottles	POB	18/*	MX Log
<ul style="list-style-type: none"> • Place bottle strap diagonally across front of body with one arm and shoulder through the strap. • All bottles come connected to the high flow connection, but can be moved to the low flow with ease. • Turn bottle ON by rotating the yellow or green knob counter-clockwise to the open position. (Knobs are all being painted green, but this is not yet complete.) • Check flow of oxygen. • Small bottles provide the following rates (at 20,000-ft. altitude): <ul style="list-style-type: none"> • 2 LPM for 46 minutes • 4 LPM for 25 minutes • Large bottles provide the following rates (at 20,000-ft. altitude): <ul style="list-style-type: none"> • 2 LPM for 120 minutes • 4 LPM for 66 minutes 			

* One required for each working crewmember. 8 at 4.25 cu. ft. and 10 at 11 cu. ft. (Note: If possible do not deplete below 500 PSI.)

Sharps Container	SC	3/0	Cabin Log
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- One each in the seat back pockets behind the last row of First Class seats, aircraft left and right.
- One each in the seat back pockets behind the last row of main cabin seats, aircraft left and right.
- Sharps containers are available to passengers who need to dispose of used needles, razor blades, etc.

Slide Raft	SR	8/7	MX Log
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- Located at each door.
- Deployed when door is opened in the armed mode.
- May be manually inflated by pulling the red inflation handle adjacent to the girt bar.

Spare Life Vests	SLV	48/48	MX Log
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- Located in the floor mounted storage 4 packages containing 6 vests each in the forward cabin, and 4 packages containing 6 vests each in the aft floor mounted storage cabin to be used as needed during a ditching.
- These vests are yellow in color but could be used by a crew member if necessary.
- The spare life vests do not effect the number of Crew / Attendant Life Vests required to be on board.
- Donning and inflation procedures are identical to CLV and ALV.

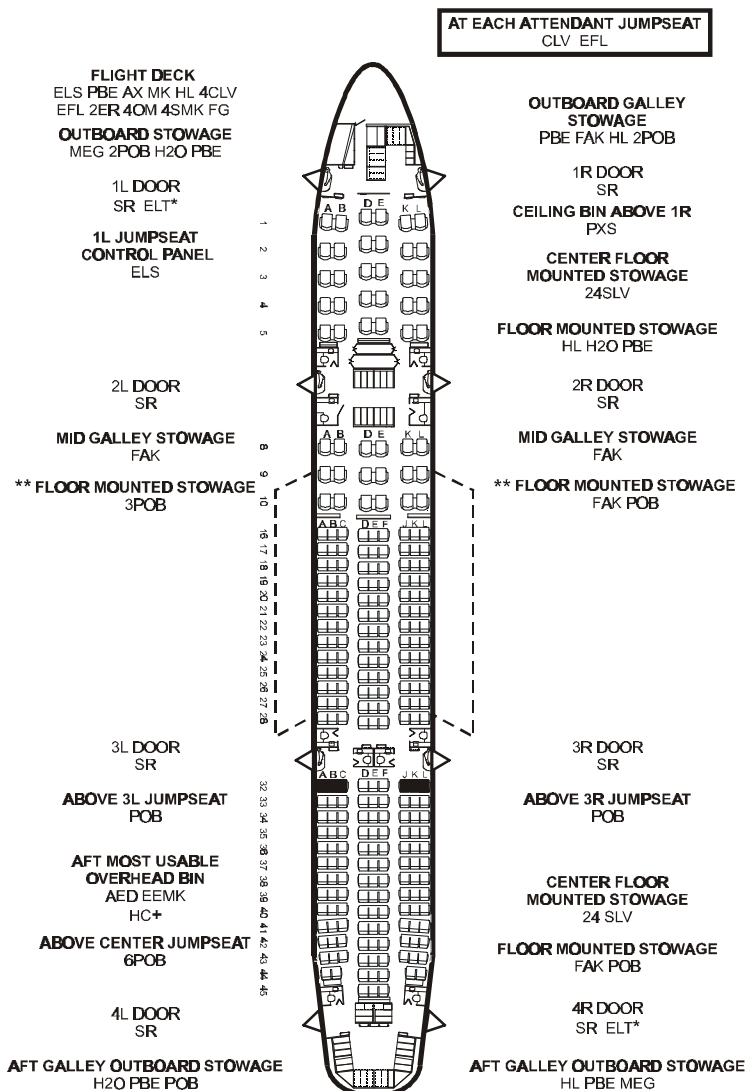
Smoke Goggles	SMK	4/4	MX Log
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- On aircraft with separate goggles, remove from stowage and don after crew oxygen is in place.
- On other aircraft goggles are part of mask.

Universal Precautions Kit	UPK	3/0	MX Log
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- Provided for use by Flight Attendants.
- For preflight inspection and operational instructions see First Aid section of Inflight Manual.
- One each in the seat back pockets behind the last row of First Class seats, aircraft left and right.
- One in the seat back pocket behind the last row of main cabin seats, aircraft left.

Emergency Equipment Locations



* ELT located in slide/raft at doors 1L and 4R.

+ Item not required emergency equipment. Shown for location only.

** On aircraft with fully extended BusinessFirst seats, the emergency Equipment located behind last row of BusinessFirst seats is located on opposite sides in center floor mounted stowage compartments.

DOORS AND WINDOWS

The airplane has eight passenger entry doors, one flight deck door (the flight deck/passenger cabin entry), and three cargo doors. It also has two center electrical and electronic (E/E) equipment access doors, one forward and one main.

The flight deck number two windows, one on the left and one on the right, can be opened by the flight crew.

An EICAS message is displayed when a passenger door, overwing exit, cargo door, access door, or flight deck window is not closed, latched, and locked.

Flight Deck Door

The aircraft is equipped with an enhanced flight deck door and integrated security system. When properly locked, this door is able to defend against unauthorized entry by brute force, penetration by bullets, or exposure to small explosive devices.

The door is controlled and monitored by a FLIGHT DECK DOOR control panel located on the aft aisle stand. It is normally locked by two independent electrical solenoids, either one of which will provide normal locking functions. The door is unlocked by the control panel or by rotating the flight deck side doorknob in either direction. The cabin-side door handle is designed to limit pulling forces on the door to 250 lbs maximum and will not unlock the door. There is a viewing port, which allows a 150° view of the area immediately outside the door.

The door is equipped with a mechanical pressure sensitive latch, which automatically allows the door to open in the event of a flight deck rapid depressurization event. An integral access panel located on the bottom portion of the door allows for emergency exit by rotating two red panel retainers and opening the panel if the door itself becomes jammed. There are instructional placards on the door for use of the emergency exit system and resetting of the door after an emergency exit.

The door and integrated security system (including control panel, status lights, and warning function) is powered from 28 volt left main DC bus and 28 volt right main DC bus. Either bus will power the entire system. With loss of both of these buses (such as standby electrical power operations, or with the aircraft unpowered on the ground) the door is electrically unlocked and all system electrical components including control panel, status lights, and warning functions are inoperative. Door system faults result in illumination (either steady or flashing depending upon mode of failure) of the red **UNLKD** light located on the door control panel.

There is an independent mechanical lock pin installed on the flight deck side of the door for use during a system fault or for additional lock redundancy during a ***significant security event***. In the event the mechanical lock pin must be used due to a system failure, a flight attendant, working crew member, or other authorized ACM / jumpseat rider must remain on the flight deck to engage / disengage the lock anytime there is only one pilot on the flight deck. This insures access to the flight deck in the event the pilot becomes incapacitated.

When the mechanical lock pin is used during a ***significant security incident***, the flight deck door should not be opened regardless of the number of pilots on the flight deck until the incident is stabilized.

There is a cabin-side FLIGHT DECK DOOR EMERGENCY ENTRANCE panel located by the left side of the door for emergency access to the flight deck, or for use as a “panic button” warning during significant security events. A “DOOR, DOOR, DOOR” warning sounds from dual speakers installed on the flight deck overhead panel when this system is activated. Two green LED maintenance test light diodes located on the same panel illuminate whenever there are electrical inputs to the respective speaker.

The primary function for the cabin mounted emergency entrance system is to afford access to the flight deck after all attempts to contact the flight deck have failed and the assumption is made that all pilots are incapacitated. Open the access door on the FLIGHT DECK DOOR EMERGENCY ENTRANCE panel and push the OPEN switch. If no pilot action is taken, it presumes that all pilots are incapacitated, and after 30 seconds the alert warning stops and the door unlocks for ***only 5 seconds*** to allow opening. If the door is not opened during this time, it will relock and the process must be repeated.

This same system may be used as an alternate means of alerting the flight crew of a ***significant security incident*** if interphone communications are not possible or timely (panic button feature). Provided both pilots are not incapacitated, they should immediately engage the HARD LOCK mode. The door remains locked and the flight crew should immediately begin attempts to communicate with the cabin to determine the problem. If communications with the cabin are not possible and the flight crew is unable to determine the severity of the incident, it will be considered a ***LEVEL 4 SECURITY INCIDENT***.

Note: This emergency system is never to be used for normal entrance to the flight deck. (The system may be used by a pilot or maintenance technician if the door has been inadvertently locked while on the ground.)

Flight Deck Number Two Windows

The flight deck number two windows can be opened on the ground or in flight. The flight deck number two windows can be used for emergency evacuation. The associated window lock lever locks or unlocks the window. With the window unlocked, rotating the window crank opens the window. To open the window:

- Rotate the window lock lever aft to the open position
- Crank the window to the full open position (the WINDOW NOT CLOSED placard is visible).

When closing the window, the window lock lever must be in the unlocked position. As the window approaches the full closed position, the force required on the crank increases. To close the window:

- Crank the window to the full closed position (the WINDOW NOT CLOSED placard is not visible)
- Rotate the window lock lever forward to the locked position.

The windows can be opened or closed in flight with minor flight deck consequences if the airplane is unpressurized. Because the force required to move the crank increases with airspeed, it is recommended not to exceed $V_{REF} + 80$ with a window open. It may not be possible to open or close the window at speeds above 250 knots. With the window open, voice, interphone, and radio audio cannot be heard due to high noise levels. Prior communications arrangements with the controlling agency should be established before opening the window. The design provides an area of relatively calm air over the open window. Forward visibility can be maintained by looking out of the open window.

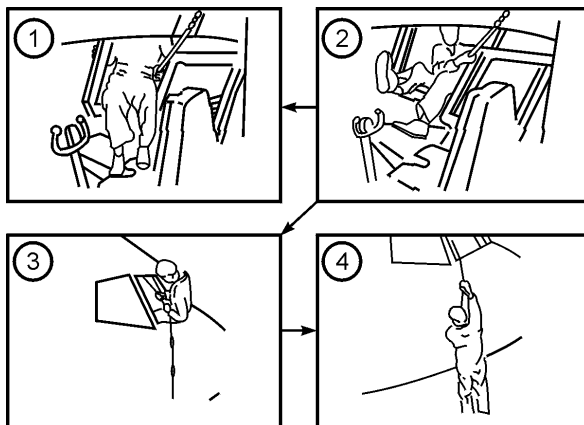
The EICAS advisory message **WINDOW FLT DECK (L OR R)** or **WINDOWS (BOTH WINDOWS)** is displayed if the window(s) are not closed and latched.

Flight Deck Window Emergency Egress

If the flight deck number two windows must be used for emergency egress, use the following procedure:

- Open the window
- Remove the bag containing the rope (above and aft of window)
- Pull on rope to ensure it is securely attached
- Throw the bag out the window (bag falls off)
- Check the first rope handhold is green and is located in the window opening
- Sit on the window sill with upper body outside
- Exit in accordance with the following illustration.

Caution: Ensure the rope is securely fastened to the airplane.



Passenger Entry Doors

The passenger entry doors are used to enter and exit the airplane, and also serve as emergency exits. There are no other passenger cabin exits. The eight passenger entry doors are paired along the airplane fuselage. The doors are identified 1 through 4 left, and 1 through 4 right. The doors can be opened or closed manually from inside or outside of the airplane.

The entry doors are translating, plug-type doors. During opening, the door first moves inward and upward, then translates outward and forward. Each door is held in the open position by a gust lock. The gust lock drops into a latch as the door nears its forward limit of travel. A window in each door allows observation outside of the airplane.

Each door has a vent panel connected to the door handle. The vent is designed to prevent pressurization to an unsafe level if the door is not fully closed, latched, and locked. Forward rotation of the door handle past the latched position closes the vent. Initial aft door handle rotation opens the vent to equalize cabin and ambient pressure. At low differential pressure, the door handle can be rotated to allow the door to open fully. At high differential pressure, the vent can be partially opened; however, a mechanical interlock prevents door opening until the differential pressure is reduced. At very high differential pressure, the vent cannot be opened.

Passenger Entry Door Flight Lock

Each door handle is automatically locked when airspeed is greater than 80 knots. The flight lock allows limited door handle rotation sufficient to partially open the door vent, but prevents door opening. If electrical power is removed or fails, the flight lock is spring-loaded to the unlocked position.

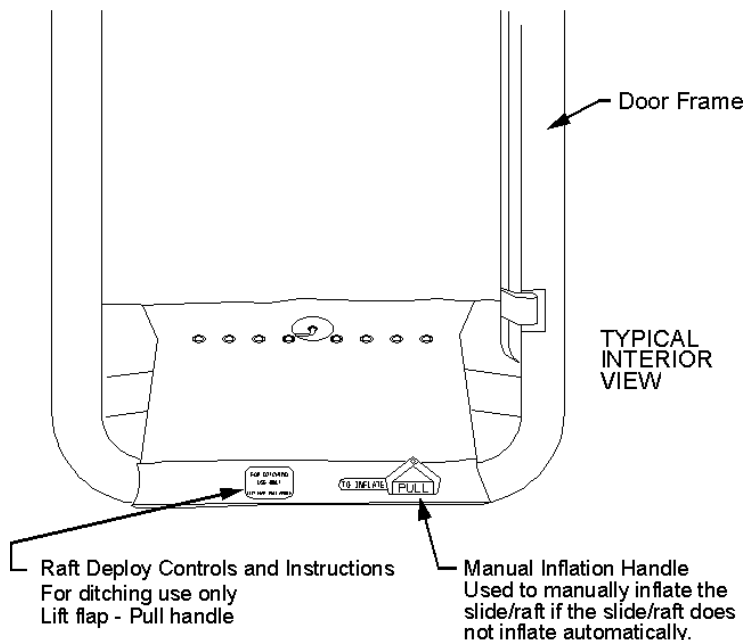
Passenger Entry Door and Slide/Raft Operation

Emergency evacuation slide/raft and pneumatic door opening systems are contained in each passenger entry door. Each door system has enough power to open the door unassisted, even if the airplane is not level because of any landing gear collapse condition. A slide/raft cover in the lower face of the door contains the slide/raft.

The emergency door opening system is armed when the mode select lever is in the ARM position. This engages the door girt bar and arms both the slide/raft and the emergency door opening systems. Once armed, moving the interior door handle to the open position operates the pneumatic opening actuator. The actuator drives the door open, and the slide/raft automatically deploys and inflates.

The emergency door opening system and the slide/raft are automatically disarmed when the door is opened from the outside. If the mode select lever is in the ARM position and the door is opened using the exterior door handle, the mode select lever automatically moves to DISARM and the door opens without slide/raft deployment.

Slide/Raft Deployed



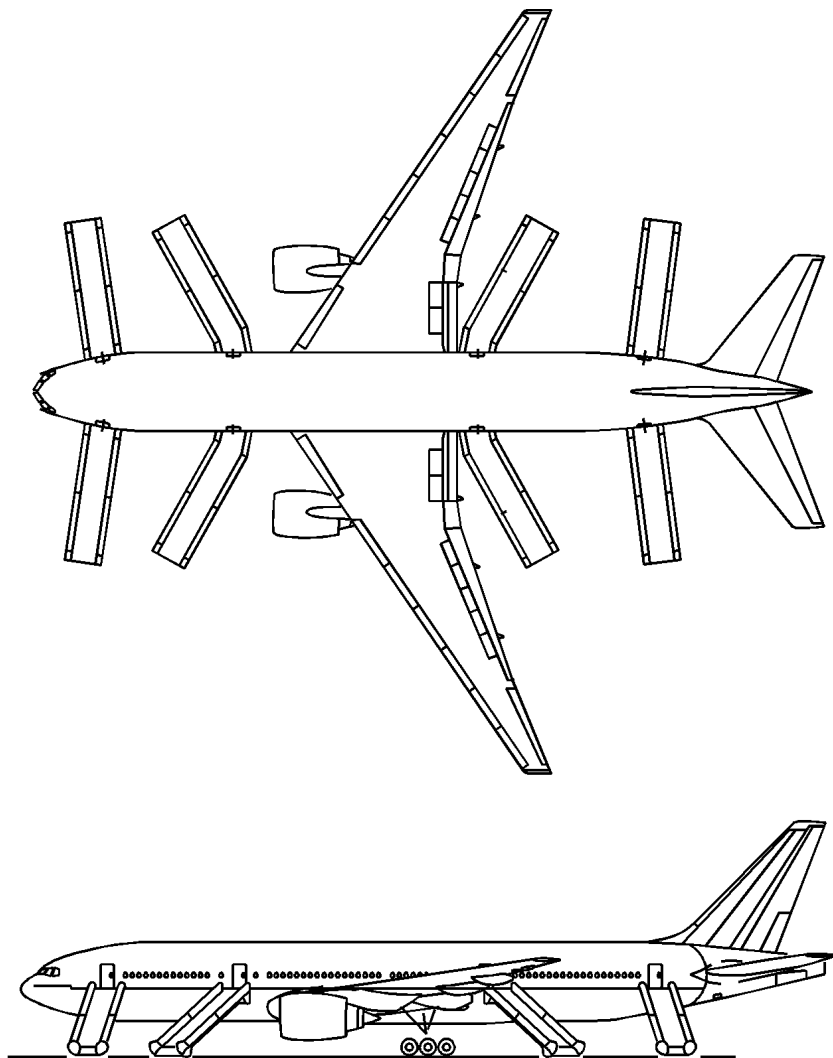
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The B777 is equipped with 8 slide rafts with the following capacities:

Exit Location	Normal Capacity	Overload Capacity
1L / 1R	65 / 65	81 / 81
2L / 2R	57 / 57	71 / 71
3L / 3R	51 / 51	63 / 63
4L / 4R	60 / 60	75 / 75
Totals	466	580

The overload capacity is calculated as the number of people inside the raft and maintaining 6" of raft above the waterline.

Evacuation Slide/Rafts



7776050

Cargo Doors

There are three cargo doors; one forward, one aft, and one bulk. All three cargo doors are located on the right side of the airplane. The cargo doors all open upward. The forward and aft cargo doors open outward and the bulk cargo door opens inward.

Both forward and aft cargo doors are normally operated electrically from an exterior or interior fuselage-mounted control panel located with each door. A control panel light indicates cargo door latching. Forward and aft cargo door locking is accomplished manually. If necessary, the forward and aft cargo doors may be operated manually.

The bulk cargo door is manually opened and closed, and is counterbalanced for ease of operation.

FLIGHT DECK SEATS

The flight deck has three seat types:

- Pilot seats (Captain and First Officer)
- First Observer seat
- Second Observer seat.

Pilot Seats

The pilot seats:

- Recline
- Adjust vertically
- Adjust forward and aft
- Adjust for thigh support
- Adjust for the lumbar region of the back.

The seats also have:

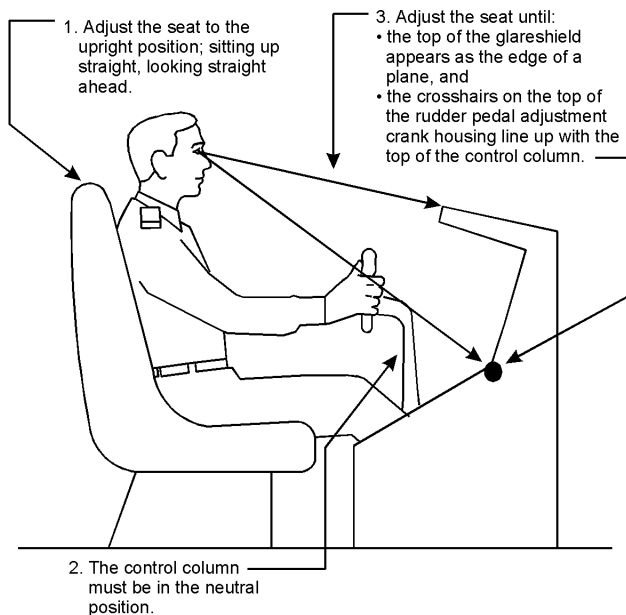
- Adjustable armrests
- Crotch straps
- Inertial-reel shoulder harnesses with manual locks
- Lap belts
- Adjustable headrests.

The seats move outboard during the last two inches of aft travel. Electric and manual controls provide forward, aft, and vertical adjustment. Manual levers provide other adjustments.

Lumbar and thigh pad support can be adjusted using the adjustment hand wheels. Armrest pitch can be adjusted using the control knob under the armrest. The armrests can be stowed vertically for easier seat access.

Adjust the seat to obtain the optimum eye position as shown on the following illustration.

Pilot Seat Adjustment



7776052

Observer Seats

The first observer seat is pedestal-mounted. It adjusts manually in the vertical, forward and aft directions. The seat has:

- A folding arm rest on the left side
- Crotch strap
- Inertial-reel shoulder harness with manual locks
- Lap belt
- Adjustable headrest.

The second observer seat is not adjustable. The seat has:

- Folding arm rests
- Crotch strap
- Shoulder harness with manual locks
- Lap belt
- Adjustable headrest.

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EMERGENCY EQUIPMENT, DOORS, WINDOWS, EICAS MESSAGES

Doors and Windows EICAS Messages

Message	Level	Aural	Condition
CONFIG DOORS	Warning	Siren	A door is not closed, latched, and locked when either engine's thrust is in the takeoff range on the ground.
DOOR AFT CARGO	Caution	Beeper	Cargo door is not closed and latched and locked.
DOOR FWD CARGO	Caution	Beeper	Cargo door is not closed and latched and locked.
DOOR BULK CARGO	Advisory		Bulk cargo door is not closed and latched and locked.
DOOR E/E, FWD ACCESS	Advisory		Access door is not closed and latched and locked.
DOOR ENTRY 1-4L, R	Advisory		Entry door is not closed and latched and locked.
DOORS	Advisory		Two or more doors are not closed and latched and locked.
DOORS AUTO	Memo		All passenger entry doors are in the automatic mode.
DOORS AUTO/MANUAL	Memo		Some passenger entry doors are in the automatic mode and some are in the manual mode.
DOORS MANUAL	Memo		All passenger entry doors are in the manual mode.
WINDOW FLT DECK L, R	Advisory		Side window is not closed and latched.
WINDOWS	Advisory		Left and right side windows are not closed and latched.

Emergency Lights and Passenger Signs EICAS Messages

Message	Level	Aural	Condition
EMER LIGHTS	Advisory		Emergency lighting system has been manually activated or emergency lights switch is OFF.
NO SMOKING ON	Memo		NO SMOKING switch is in the on position.
PASS SIGNS ON	Memo		The NO SMOKING and SEAT BELTS switches are in the on position.
SEATBELTS ON	Memo		The SEAT BELTS switch is in the on position.

Oxygen System EICAS Messages

Message	Level	Aural	Condition
CREW OXYGEN LOW	Advisory		Crew oxygen pressure is low.
PASS OXYGEN ON	Advisory		Passenger oxygen system is activated.

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ANTI-ICE & RAIN SYSTEM DESCRIPTION**INTRODUCTION**

The anti-ice and rain systems include:

- Automatic ice detection
- Engine anti-ice
- Wing anti-ice
- Flight deck window heat
- Windshield wipers
- Probe heat.

AUTOMATIC ICE DETECTION SYSTEM

The automatic ice detection system detects airplane icing in flight. Automatic ice detection is inhibited on the ground. The system provides signals to control the engine and wing anti-ice systems when those systems are in the automatic mode.

The system consists of two ice detector probes, one on each side of the forward fuselage. If the probes detect ice build-up they are automatically de-iced.

When either probe detects ice build-up more than once, the engine anti-ice valves automatically open (ENGINE ANTI-ICE selectors in AUTO) and the engine cowl inlets are de-iced. When the probes detect ice build-up several times, the wing anti-ice valves automatically open (WING ANTI-ICE selector in AUTO) and the wing leading edges are de-iced. When the system no longer detects icing, all anti-ice valves automatically close.

ENGINE ANTI-ICE SYSTEM

The engine anti-ice system uses engine bleed air to provide engine cowl inlet ice protection. Engine anti-ice can be operated in flight or on the ground. The engine anti-ice (EAI) annunciation appears above the EICAS N₁ indication when an engine anti-ice valve is open. The left and right engines have identical, independent anti-ice systems. This allows the remaining system to operate if one engine fails.

Engine Anti-Ice System Automatic Operation

In flight, when the ENGINE ANTI-ICE selector is in AUTO, engine anti-ice system operation is automatic. When ice is detected, the engine anti-ice valves open and bleed air is automatically supplied to the engine cowl inlets.

When ice is no longer detected, the engine anti-ice valves close and bleed air is no longer supplied to the engine cowl inlets.

Engine Anti-Ice System Manual Operation

On the ground or in flight, turning the ENGINE ANTI-ICE selectors ON allows engine bleed air to anti-ice the engine cowl inlets. The selectors must be ON for the engine anti-ice system to operate on the ground.

Engine Anti-Ice Leak Detection System

Each engine has a dual loop anti-ice system duct leak detection system. If an anti-ice duct leak is detected, the affected engine anti-ice valve closes.

WING ANTI-ICE SYSTEM

The wing anti-ice system provides bleed air to three midwing leading edge slats on each wing. Wing anti-ice can be operated in flight only. It is inhibited on the ground. If the total air temperature (TAT) is above 10°C, both manual and automatic wing anti-ice operation is inhibited for five minutes after takeoff. The inhibit is removed any time TAT drops below 10°C.

An additional wing anti-ice inhibit, independent of TAT, is active during the takeoff phase of flight. Automatic wing anti-ice operation is inhibited for 10 minutes after takeoff. Manual wing anti-ice operation is not affected by this inhibit.

The wing anti-ice (WAI) annunciation is displayed below the EICAS N₁ indication when a wing anti-ice valve is open. If a bleed source is lost and bleed duct isolation has not occurred, the isolation valves automatically open to maintain anti-icing to both wings.

Wing Anti-Ice System Automatic Operation

In flight, when the WING ANTI-ICE selector is in AUTO, wing anti-ice system operation is automatic. When ice is detected, the wing anti-ice valves open and bleed air is automatically supplied to the affected slats. When ice is no longer detected, the wing anti-ice valves close and bleed air is no longer supplied to the slats. If one wing anti-ice valve fails closed, the wing anti-ice system automatically closes the other valve to prevent asymmetrical wing anti-icing.

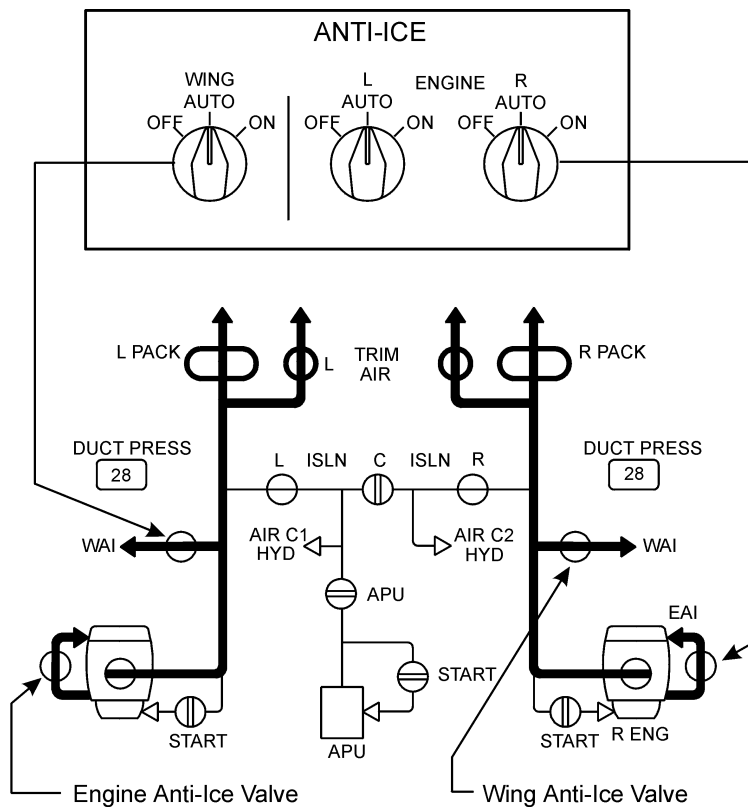
Wing Anti-Ice System Manual Operation

In flight, turning the WING ANTI-ICE selector ON opens the wing anti-ice valve in each wing, allowing bleed air to flow from the bleed air manifold to the affected slats.

Wing Anti-Ice System Leak Detection System

Wing anti-ice system leak detection is accomplished by the bleed duct leak and overheat detection system. Refer to Section 6.2, Air Systems, Bleed Air System Description.

ANTI-ICE SYSTEM SCHEMATIC



7778001

Flight Deck Window Heat

All flight deck windows are electrically heated. The forward windows have exterior surface anti-icing, and exterior and interior surface anti-fogging protection. The side windows have interior surface anti-fogging protection only.

The WINDOW HEAT switches control heating for all flight deck windows. With the switches **ON**, window heat operates as soon as electrical power is established. The windows are protected from thermal shock when the switches are initially placed **ON**.

A backup anti-fogging system for the forward windows operates automatically if there is a primary window heat system failure.

Windshield Wipers

The rain removal system for the forward windows consists of wipers and a hydrophobic coating on the windows.

The forward windows are equipped with independently controlled, two-speed wipers. With a WIPER selector in the **OFF** position, the respective wiper is off and stowed.

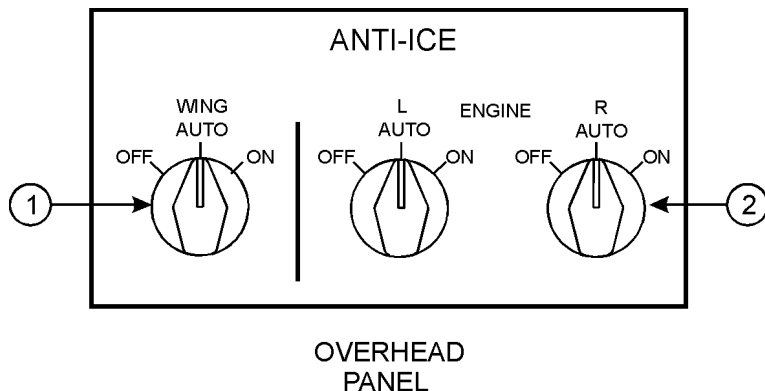
Probe Heat

There are three pitot probes, one on the left and two on the right side of the forward fuselage. On the ground with either engine operating, the probes are automatically heated at reduced power to avoid overheating. In flight, they are automatically heated at full power.

There is one total air temperature (TAT) probe, aft of the left pitot probe. This probe is heated in flight only.

Two angle-of-attack (AOA) sensors, mounted aft of and above the pitot probes on each side of the fuselage, are heated when either engine is operating.

CONTROLS AND INDICATORS

ANTI-ICE PANEL

7778002

① WING ANTI-ICE Selector

OFF - Both wing anti-ice valves are commanded closed.

AUTO - In flight, both wing anti-ice valves are commanded opened or closed automatically by the ice detection system.

ON - In flight, both wing anti-ice valves are commanded open.

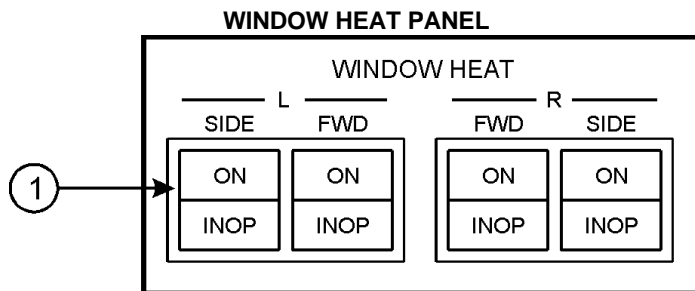
② ENGINE ANTI-ICE Selectors

OFF - The engine anti-ice valve is commanded closed.

AUTO - In flight, the engine anti-ice valve is opened or closed automatically by the ice detection system.

ON - The engine anti-ice valve is commanded open.

Note: If the ENG ANTI-ICE selector is in AUTO and the anti-ice valve is commanded open, or if the selector is in ON, then approach idle is selected by the EEC.

WINDOW HEAT AND WIPER PANELS**OVERHEAD PANEL**

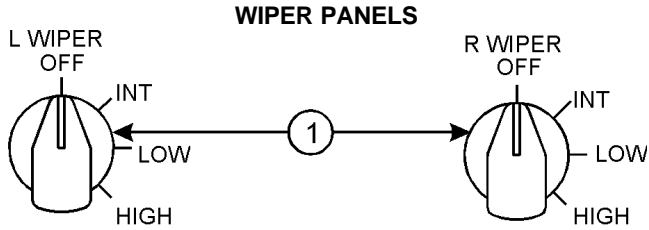
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① WINDOW HEAT Switches

ON - Window heat is applied to the selected windows.

INOP (inoperative) illuminated (amber) -

- The switch is OFF,
- An overheat is detected, or
- A system fault has occurred.



OVERHEAD PANEL

7778004

① WIPER Selectors

OFF - The wiper is stowed at the base of the window.

INT (intermittent) - The wiper operates intermittently.

LOW - The wiper operates at low speed.

HIGH - The wiper operates at high speed.

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ANTI-ICE EICAS MESSAGES

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
ANTI-ICE ENG L, R	Advisory		Engine anti-ice valve remains closed when commanded open.
ANTI-ICE LEAK ENG L, R	Caution	Beeper	High temperature anti-ice bleed air leak is detected in the affected engine.
ANTI-ICE LOSS ENG L, R	Advisory		Anti-ice bleed air for the affected engine is no longer available.
ANTI-ICE ON	Advisory		Any anti-ice selector is ON, air temperature is above 10 degrees C, and ice is not detected.
ANTI-ICE WING	Advisory		One or both wing anti-ice valves has failed closed.
HEAT PITOT C	Advisory		Center pitot probe heat is inoperative.
HEAT PITOT L	Advisory		Left pitot probe heat is inoperative.
HEAT PITOT L+C+R	Advisory		All pitot probe heats are inoperative.
HEAT PITOT R	Advisory		Right pitot probe heat is inoperative.
ICE DETECTORS	Advisory		Ice detection has failed.
ICING ENG	Caution	Beeper	Ice is detected and one or both engine anti-ice selectors are OFF.
ICING WING	Advisory		Ice is detected and wing anti-ice selector is OFF, or ice is detected and wing anti-ice takeoff inhibit is active.
WINDOW HEAT	Advisory		Two or more window heats are off on the ground.
WINDOW HEAT L, R FWD	Advisory		Primary window heat for the affected forward window is off.
WINDOW HEAT L, R SIDE	Advisory		Window heat for the affected side window is off.

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AUTO FLIGHT SYSTEM DESCRIPTION**INTRODUCTION**

The automatic flight control system consists of the Autopilot Flight Director System (AFDS) and the autothrottle system. The AFDS is controlled using the Mode Control Panel (MCP) and the Flight Management Computer (FMC). The autothrottle is controlled through the MCP and the FMC.

Normally, the AFDS and autothrottle are controlled automatically by the FMC to perform climb, cruise, descent, and approach flight path guidance.

AUTOPILOT FLIGHT DIRECTOR SYSTEM

The AFDS consists of three Autopilot Flight Director Computers (AFDCs) and the MCP.

The MCP provides control of the autopilot, flight director, altitude alert, and autothrottle systems. The MCP is used to arm or engage AFDS modes, and establish altitudes, speeds, and climb/descent profiles.

The AFDCs provide control of the flight directors, and autopilot. Flight director information is displayed on the Primary Flight Displays (PFDs). The AFDS does not have servos to move the primary flight control surfaces. The autopilot controls the elevators, ailerons, flaperons, and spoilers through the Primary Flight Computers (PFCs), Actuator Control Electronics (ACEs), and Power Control Units (PCUs). Autopilot rudder commands are added only during an autopilot approach and landing. The autopilot controls nose wheel steering during rollout after an automatic landing.

The AFDS autopilot commands go to the PFCs through the flight control AIRINC 629 buses. The PFCs select which signal to use. If an input is not valid it is removed from the computation. This process is called "Mid-Value Selection" and "Voting."

The PFCs process and change the autopilot commands to surface commands. The surface commands from the PFCs go to the ACEs then to the PCUs to move the flight control surfaces.

The PFCs send backdrive commands to the AFDCs to operate the backdrive actuators. The backdrive actuators move the control columns, control wheels and rudder pedals to a position that represents the autopilot command. Transducers on the column, wheel and rudder pedals supply position feedback to the PFCs through the ACEs.

Note: There are 6 backdrive actuators; one for each of the control columns, control wheels and rudder pedals. Three left backdrive actuators are controlled by the left autopilot and control the left control column, wheel and rudder pedals. Three right backdrive actuators are controlled by the right autopilot and control the right control column, wheel and rudder pedals.

All 6 backdrive actuators operate in the approach mode (LAND 3 or LAND 2). When not in the approach mode only 2 backdrive actuators (column and wheel) operate for the controlling autopilot (left or right).

The AFDS does not control the horizontal stabilizer. Pitch trim control is from the primary flight control system.

MCP Mode Selection

MCP mode switches are used to select automatic flight control and flight director modes. A light in the lower half of each switch illuminates to indicate that the mode is selected. Mode engagement is indicated by the PFD roll and pitch flight mode annunciations. Autothrottle modes are discussed later in this section.

Most modes engage with a single push. These modes include:

- Flight Level Change (FLCH SPD)
- Heading Hold (HDG HOLD)
- Track Hold (TRK HOLD)
- Heading Select (HDG SEL)
- Track Select (TRK SEL)
- Vertical Speed (V/S)
- Flight Path Angle (FPA)
- Altitude hold (ALT).

Other modes arm or engage with a single push. These modes are:

- Lateral Navigation (LNAV)
- Vertical Navigation (VNAV)
- Localizer (LOC)
- Approach (APP).

All modes except APP (below 1,500 feet Radio Altitude (RA) with LOC and G/S captured) can be disengaged by selecting another mode. All modes can be disengaged by disconnecting the autopilot and turning both flight directors off. After localizer and glideslope capture, the localizer and glideslope modes can only be disengaged by disconnecting the autopilot and turning both flight directors off, engaging the go-around mode, or if above 1,500 feet RA, by reselecting APP (roll and pitch will revert to default modes; for roll either ATT or HDG HLD/TRK HLD, for pitch either VS or FPA). The VNAV, LNAV, LOC and APP modes can be disarmed by pushing the mode switch a second time.

Desired target values can be selected on the MCP for:

- Airspeed
- MACH
- Heading
- Track
- Vertical speed
- Flight path angle
- Altitude.

All of these parameters except vertical speed and flight path angle can be preselected prior to autopilot or flight director engagement.

Autopilot Engagement

There are two autopilot engage switches on the MCP. The autopilot is engaged by pushing either switch. All available autopilot channels engage; however, only the left or right autopilot controls the aircraft. During an approach, after **LAND 3** or **LAND 2** is annunciated, both the left and right autopilots control the aircraft. The center autopilot compares the signals from the left and right autopilots and is used as a voter when all signals are not the same.

Autopilot Disengagement

Normal autopilot disengagement is through either control wheel autopilot disconnect switch. The autopilots can also be disengaged by:

- The MCP autopilot disengage bar, or
- Overriding with the control column, control wheel, or rudder pedals (Rudder pedals will only disengage the autopilots with **LAND 2** or **LAND 3** annunciated).

Note: Override force on the control wheel is 27 lbs., the control column is 50 lbs. In Autoland the control wheel is 49 lbs., the control column is 81 lbs. and the rudder is 186 lbs.

AFDS Failures

During autopilot operation, failures affecting the engaged mode are annunciated on the PFD. If the failure affects only the operating mode:

- The autopilot remains engaged in an attitude stabilizing mode
- An amber line is drawn through the mode
- The EICAS caution message **AUTOPILOT** is displayed.

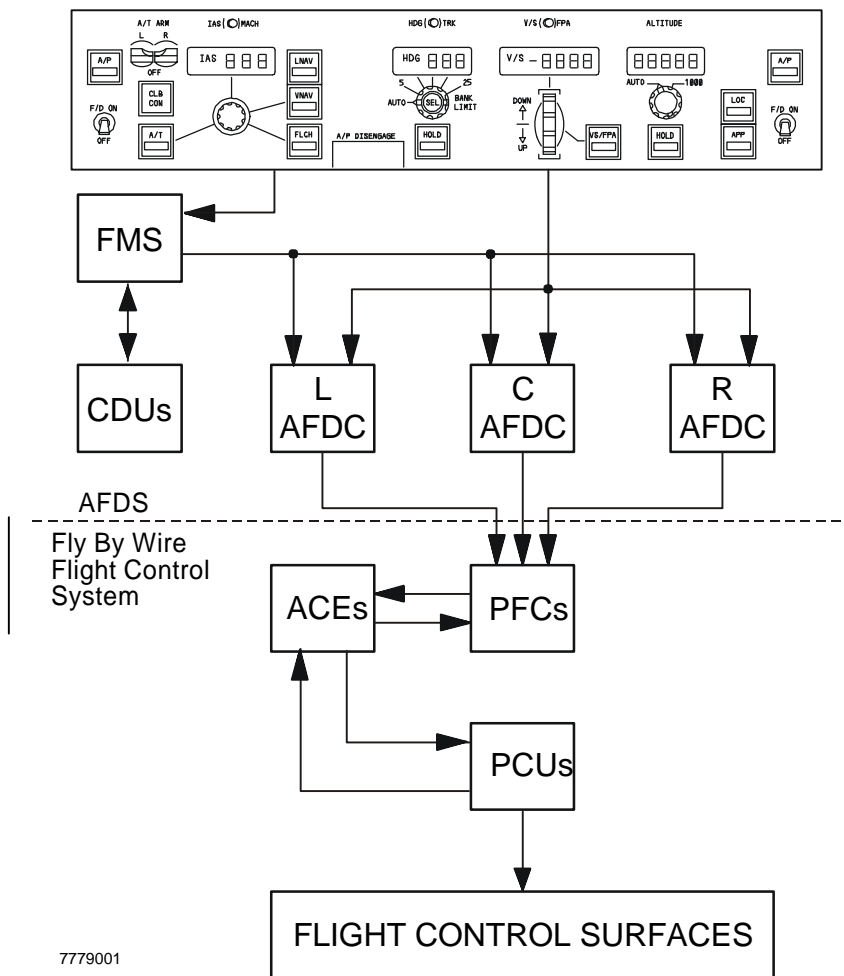
Failures affecting all autopilot modes result in an autopilot disconnect. The EICAS warning message **AUTOPILOT DISC** is displayed if the autopilot is manually or automatically disconnected. Depending on the system failure, it may be possible to re-engage an autopilot by pushing the autopilot engage switch.

Flight Director Display

The flight director steering indications (Pitch and Roll Bars) are normally displayed any time the related flight director switch is ON.

The steering indications are also displayed when the related flight director switch is OFF and a TO/GA switch is pushed, if airspeed is greater than 80 knots and the leading edge slats are not retracted. In this case, the flight director display can be removed by cycling the respective flight director switch ON and then OFF.

A flight director mode failure, in either pitch or roll, causes the respective steering bars to disappear. The stall and overspeed protection functions will also cause the flight director pitch bar to disappear.



AUTOPILOT FLIGHT DIRECTOR SYSTEM SCHEMATIC

AFDS Status Annunciation

The following AFDS status annunciations are displayed just above the PFD attitude display:

- **FLT DIR** (the flight director is ON and the autopilots are not engaged)
- **A/P** (the autopilots are engaged)

The following are Autoland status annunciations:

- **LAND 3** (three autopilots are engaged and all triple redundant systems are operating normally for an automatic landing)
- **LAND 2** (system triple redundancy is reduced; or in some cases, only two autopilots are available)
- **NO AUTOLAND** (the AFDS is unable to make an automatic landing).

With a **LAND 3** indication, the autopilot system level of redundancy is such that a single fault cannot prevent the autopilot system from making an automatic landing (fail operational).

With a **LAND 2** indication, the level of redundancy is such that a single fault cannot cause a significant deviation from the flight path (fail passive).

An EICAS message is displayed for any fault which limits the capability of the automatic landing system. Aural alerts for EICAS messages not affecting safety of flight are inhibited until after touchdown. Changes in autoland status below 200 feet, other than a transition to **NO AUTOLAND** status, are inhibited.

AFDS Flight Mode Annunciations (FMA)

The flight mode annunciations are displayed just above the PFD AFDS status annunciations. The mode annunciations, from left to right, are:

- Autothrottle
- Roll
- Pitch.

Engaged or captured modes are shown at the top of the flight mode annunciator boxes in large green letters. Armed modes (except for TO/GA) are shown in smaller white letters at the bottom of the flight mode annunciator boxes.

Autothrottle Modes

The autothrottle modes are:

- THR - The autothrottle applies thrust to maintain the vertical speed required by the pitch mode.
- THR REF - Thrust is set to the selected thrust limit displayed on EICAS.
- IDLE - Displayed while the autothrottle moves the thrust levers to idle; required by the pitch mode. IDLE mode is followed by HOLD mode.
- HOLD - The thrust lever autothrottle servos are inhibited. The pilot can set the thrust levers manually.
- SPD - The autothrottle maintains the selected speed displayed on the PFD. Speed can be set by the MCP IAS / MACH selector or by the FMC, as shown on the Control Display Unit (CDU) CLIMB, CRUISE, or DESCENT page. The autothrottle will not exceed the V_{MO} / M_{MO} , flap / slat or gear operating speed limits or the thrust limits displayed on the EICAS.

Note: Autothrottles will provide minimum speed protection.

Roll Modes

The roll modes are:

TO/GA -

- On the ground, with both flight directors OFF, TO/GA is engaged by selecting either flight director switch ON or when a TO/GA switch is pushed with airspeed greater than 80 KTS. TO/GA roll guidance is wings level at lift-off until 5 feet RA then it maintains ground track.
- In flight, TO/GA is armed when the leading edge slats are extended or at glideslope capture. There is no flight mode annunciation for TO/GA armed in flight. TO/GA is engaged in flight by pushing a TO/GA switch. The AFDS maintains the ground track present at mode engagement.

LNAV -

- LNAV (armed) - LNAV is armed to engage when parameters are met.
- LNAV (engaged) - LNAV engages if above 50 feet RA, and within 2 1/2 NM of the active route leg. The AFDS follows the active leg displayed on the ND.

HDG -

- HDG SEL (engaged) - The airplane is turning to, or is on the heading selected in the MCP heading / track window.
- HDG HOLD (engaged) - The AFDS holds the present heading. If turning, the AFDS holds the heading reached after rolling wings level.

TRK -

- TRK SEL (engaged) - The airplane is turning to, or is on the track selected in the MCP heading / track window.
- TRK HOLD (engaged) - The AFDS holds the present track. If turning, the AFDS holds the track reached after rolling wings level.

ATT (engaged) - When the autopilot is first engaged or the flight director is first turned on in flight; or when the approach mode is disengaged by reselecting APP after LOC capture (above 1500 feet RA).

- If bank angle is greater than 30 degrees – The AFDS returns to 30 degrees of bank.
- If bank angle is between 30 degrees and 5 degrees – The AFDS holds the bank angle.
- If bank angle is 5 degrees or less – The AFDS commands wings level (and annunciates **HDG HLD** or **TRK HLD**).

Note: The AFDS holds the heading (or track, if selected) it sees as it passes through 3 degrees.

LOC -

- LOC (armed) - The AFDS captures the localizer when within range and within 120 degrees of the localizer track.
- LOC (engaged) - The AFDS follows the selected localizer course.

ROLLOUT -

- ROLLOUT (armed) - Displayed below 1500 feet RA and engages about 2 feet RA.
- ROLLOUT (engaged) - After touchdown, the AFDS uses rudder and nosewheel steering to keep the airplane on the localizer centerline.

Pitch Modes

The pitch modes are:

TO/GA -

On the ground, with both flight directors OFF, TO/GA is engaged by selecting either flight director switch ON or by pushing either TO/GA switch with airspeed greater than 80 knots. The flight director PFD pitch bar indicates an initial pitch of eight degrees up.

After takeoff, if the climb rate is below 600 FPM, the AFDS pitch command is to hold attitude. For climb rates between 600 FPM and 1200 FPM, the AFDS pitch command is a mix of airspeed and attitude. For climb rates above 1200 FPM, the AFDS pitch command is a target airspeed of:

- V_2 plus 15 knots, or
- If current airspeed remains above the target speed for 5 seconds, the target airspeed is reset to current airspeed, to a maximum of V_2 plus 25 knots, or
- The IAS / MACH window speed if the IAS / MACH window speed is changed to a speed greater than the target speed.

Note: The AFDS uses the speed set in the IAS / MACH window prior to takeoff for V_2 .

If an engine fails during takeoff, the AFDS pitch command is a mix of airspeed and attitude for climb rates below 1200 FPM. For climb rates above 1200 FPM the AFDS pitch command is a target airspeed of:

- V_2 , if airspeed is below V_2 , or
- Existing speed, if airspeed is between V_2 and $V_2 + 15$, or
- $V_2 + 15$, if airspeed is above $V_2 + 15$.

In phases of flight other than takeoff, TO/GA is armed whenever the leading edge slats are not retracted, or at glideslope capture. There is no annunciation for TO/GA armed.

If a go-around is initiated, the commanded speed is the MCP IAS / MACH window speed or current airspeed, whichever is higher, to a maximum of the IAS / MACH window speed plus 25 knots. GA is displayed as the thrust limit on the primary EICAS engine display.

VNAV -

VNAV is armed by pushing the VNAV switch (the switch bar light is displayed and **VNAV** is annunciated on the PFD pitch mode annunciator in small white characters below the current pitch mode).

VNAV engages 400 feet above runway elevation after takeoff, if armed. VNAV engages in the appropriate VNAV mode as required to maintain the current flight path:

- VNAV SPD (engaged) - The AFDS maintains the FMC speed displayed on the PFD airspeed indicator. The PFD airspeed indicator displays MCP IAS / MACH window airspeed or (if window blank) CDU CLIMB or DESCENT page speed.
- VNAV PTH (engaged) - The AFDS maintains FMC / CDU altitude or descent path with pitch commands.

Note: If the MCP altitude window is set to the current cruise altitude as the airplane approaches the top of descent, the CDU scratchpad message **RESET MCP ALT** displays.

- VNAV ALT (engaged) - When a conflict occurs between the VNAV profile and the MCP altitude, the airplane levels and the pitch flight mode annunciation becomes **VNAV ALT**. VNAV ALT maintains altitude. To continue the climb or descent, change the MCP altitude and push the altitude selector or change the pitch mode.

V/S (engaged) - Pushing the MCP VS/FPA switch, opens the vertical speed window to display the current vertical speed. Pitch commands maintain the rate of climb or descent selected in the VS/FPA window.

FPA (engaged) - Pushing the MCP VS/FPA switch opens the flight path angle window to display the current flight path angle. Pitch commands maintain the flight path angle selected in the VS/FPA window.

FLCH SPD (engaged) - Pushing the MCP FLCH switch opens the IAS / MACH window (if blanked). Pitch commands maintain IAS / MACH window airspeed or MACH.

ALT (engaged) - Altitude hold mode is engaged by:

- Pushing the MCP altitude HOLD switch, or
- Capturing the selected altitude from a V/S, FPA, or FLCH climb or descent.

G/S (engaged) - The AFDS follows the ILS glideslope.

FLARE (armed) - During an autoland, FLARE is displayed below 1,500 feet RA.

FLARE (engaged) - During an autoland, flare engages between 60 and 40 feet RA. FLARE accomplishes the autoland flare maneuver so the AFDS can transition to the ROLLOUT mode.

AUTOTHROTTLE SYSTEM

The autothrottle system provides automatic thrust control from takeoff through landing.

Autothrottle operation is controlled from the MCP and the CDUs. The MCP provides mode and speed selection. The CDU provides FMC thrust reference mode selection. When the VNAV mode is selected, the FMC selects the autothrottle modes and target thrust values. Refer to Section 6.11, Flight Management, Navigation, for FMS and CDU operation.

The autothrottle can be operated without using the flight director or the autopilot. In this condition, the autothrottle operates in either the THR REF, SPD, HOLD or IDLE modes.

If the autothrottle is used during a manual landing, thrust is automatically reduced to IDLE at 25 feet RA if the pitch mode is VNAV SPD, VNAV PTH, V/S, FPA, or G/S. The autothrottle does not automatically retard if the pitch mode is TO/GA or FLCH.

The autothrottle can be manually overridden at any time. It can be disconnected by pushing either thrust lever autothrottle disconnect switch.

The autothrottle can be re-engaged by pushing the MCP A/T switch, selecting FLCH or VNAV, or pushing a TO/GA switch.

The EICAS advisory message **AUTOTHROTTLE L** or **R** is displayed when the respective autothrottle servo fails. If the autothrottle is engaged and only one autothrottle is armed, the PFD autothrottle flight mode annunciation displays **L** or **R** preceding the mode. For example, **L SPD** indicates only the left autothrottle is engaged in the speed mode.

Autothrottle Thrust Lever Operation

The autothrottle system moves either or both thrust levers to provide speed or thrust control, depending on the mode engaged.

The thrust levers can be manually positioned without disengaging the autothrottle. After manual positioning, the autothrottle system repositions the thrust levers to comply with the engaged mode. The autothrottle system does not reposition the thrust levers while in the HOLD mode.

Autothrottle Disconnect

The autothrottle system can be disconnected manually by positioning both the MCP *A/T ARM* switches to OFF or by pushing either thrust lever autothrottle disconnect switch. The left or right autothrottle can be disconnected by positioning the respective *A/T ARM* switch to OFF.

Autothrottle disconnect occurs automatically:

- If a fault in the engaged autothrottle mode is detected
- When either reverse thrust lever is raised to reverse idle
- If the thrust levers are overridden during a manual landing, after the autothrottle has begun to retard the thrust levers to idle
- When both engines are shut down.

The EICAS caution message **AUTOTHROTTLE DISC** is displayed and an aural alert sounds when the autothrottle is manually or automatically disconnected.

The EICAS caution message and aural alert are inhibited if the disconnect occurs because of reverse thrust.

AUTO FLIGHT OPERATIONS

Auto Flight Takeoff and Climb

Takeoff is a flight director only function of the takeoff / go-around (TO/GA) mode. The autopilot may be engaged after takeoff.

During preflight:

- With the autopilot disengaged and both flight director switches OFF, engagement of TO/GA roll and pitch mode occurs when the first flight director switch is positioned ON.
- The PFD displays FLT DIR as the AFDS status and TO/GA as the pitch and roll flight mode annunciations.
- The pitch command is a fixed attitude (about eight degrees up).
- The roll command is wings level.

During takeoff prior to lift-off:

- With speed less than 50 KIAS, pushing a TO/GA switch engages the autothrottle in the thrust reference (THR REF) mode. The thrust levers advance to the selected thrust limit.

Note: If the autothrottle is not engaged by 50 knots, it cannot be engaged until above 400 feet AGL.

- At approximately 80 knots, the autothrottle mode annunciation changes to **HOLD**.
- With speed greater than 80 knots, pushing a TO/GA switch disarms LNAV and VNAV.
- During takeoff, the FMC records the barometric altitude as the airplane accelerates through 100 knots. This altitude is used to engage VNAV, enable autothrottle activation (if not active), command acceleration for flap retraction, and set climb thrust if an altitude has been selected.

Note: Radio altitude is used for engagement of LNAV.

At lift-off:

- If the climb rate is above 1200 FPM the pitch command target speed is $V_2 + 15$. If current airspeed remains above the target speed for 5 seconds, the target airspeed is reset to current airspeed (limited to a maximum of $V_2 + 25$).
- If an engine failure occurs on the ground, the pitch command target speed at lift-off is V_2 or airspeed at lift-off, whichever is greater.
- The roll command maintains ground track above 5 feet RA.

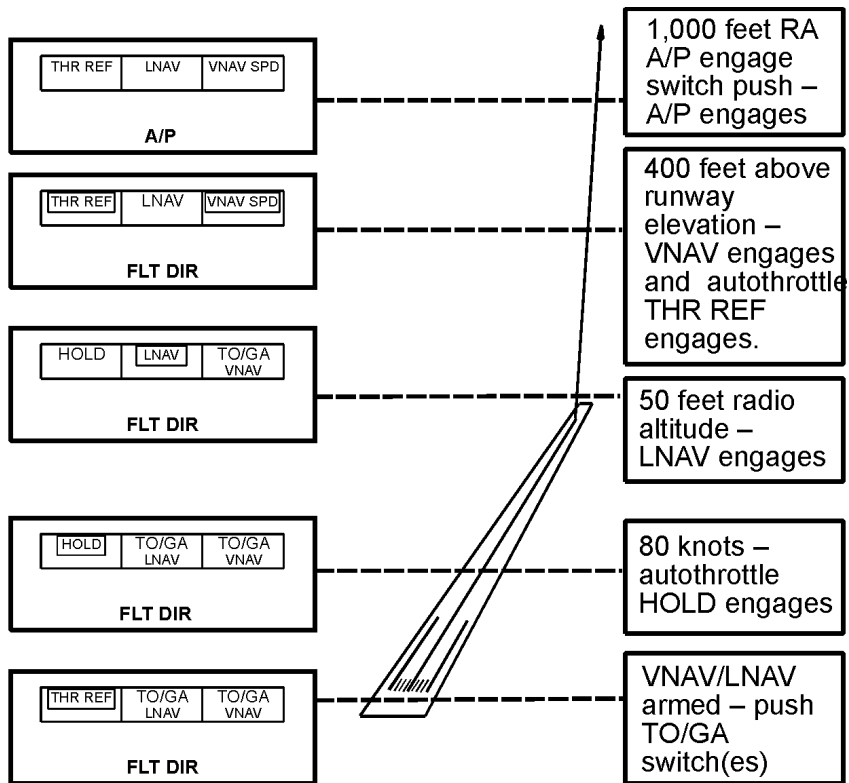
After lift-off:

- If an engine failure occurs and the climb rate is above 1200 FPM, the pitch command target speed is:
 - V_2 , if airspeed is below V_2
 - Existing speed, if airspeed is between V_2 and $V_2 + 15$
 - $V_2 + 15$, if airspeed is above $V_2 + 15$.
- If a TO/GA switch is pushed:
 - Reduced thrust takeoff is removed (maximum takeoff power is selected).
 - The autothrottle engages in THR REF.
 - Disarms AFDS modes.
- At 50 feet RA, LNAV engages, if armed. Roll commands bank to track the active route.
- At 400 feet above runway elevation, VNAV engages, if armed. Pitch commands the current airspeed. The autothrottle sets the selected reference thrust and annunciates THR REF.
- At acceleration height, pitch commands speed to 5 knots below takeoff flap placard speed. As flaps are retracted, pitch commands an acceleration to 5 knots below the placard speed of the commanded flap position.

-
- When flaps are up, pitch commands an acceleration to VNAV climb speed. VNAV climb speed is:
 - 250 knots, or
 - $V_{REF} 30 + 80$ knots for engine out.
 - At thrust reduction point (either an altitude or a flap position), the FMC changes the thrust limit to the armed climb limit (CLB, CLB 1, or CLB 2).

The TO/GA mode is terminated by selecting any other pitch and roll mode; automatic LNAV/VNAV engage terminates TO/GA mode.

Auto Flight Takeoff Profile



Auto Flight En Route

The autopilot and/or the flight director can be used after takeoff to fly a lateral navigation track (LNAV) and a vertical navigation track (VNAV) provided by the FMS. Using LNAV and VNAV ensures the most economical operation.

Other roll modes available are:

- Heading Hold (HDG HOLD)
- Heading Select (HDG SEL)
- Track Hold (TRK HOLD)
- Track Select (TRK SEL).

Other pitch modes available are:

- Altitude hold (ALT)
- Flight level change (FLCH SPD)
- Vertical Speed (V/S)
- Flight Path Angle (FPA).

Profile illustrations show the use of LNAV and VNAV.

Auto Flight Approach and Landing

The AFDS provides autopilot guidance for precision approaches.

Pushing the APP switch arms the localizer roll mode and the glideslope pitch mode.

Pushing the LOC switch arms the AFDS for localizer tracking. Descent on the localizer can be accomplished using VNAV, V/S, FLCH, or FPA pitch modes. The localizer mode cannot capture if the intercept angle exceeds 120 degrees.

All other non-precision approaches can be flown using LNAV and VNAV modes, or HDG SEL, TRK SEL, V/S, or FPA modes.

Runway Alignment

Runway alignment is a submode of the approach mode. With crosswinds, the crab angle is reduced at touchdown. Runway alignment also compensates for a single engine approach.

For crosswinds requiring more than 10 degrees of crab angle, runway alignment occurs at 500 feet AGL. A sideslip of 5 degrees is established to reduce the crab angle. This configuration is maintained until touchdown. The airplane lands with the upwind wing low.

For crosswinds requiring a crab angle of between 5 and 10 degrees, an initial alignment occurs at 500 feet AGL, followed by a second alignment at 200 feet AGL. The initial alignment initiates a sideslip to reduce the crab angle to 5 degrees. This configuration is maintained to 200 feet AGL, where a second sideslip alignment increases the sideslip to further reduce the touchdown crab angle.

For crosswinds requiring a crab angle of less than 5 degrees, no runway alignment occurs until 200 feet AGL, where a sideslip is introduced to align the airplane with the runway.

If an engine fails prior to the approach, the AFDS introduces a sideslip at 1,300 feet AGL. This establishes a wings level configuration. If an engine fails during the approach, the wings level configuration is established when the engine failure is detected.

In the event of moderate or strong crosswinds from the side opposite the failed engine, no wings level sideslip is commanded, since the airplane is already banked into the wind.

Flare

The flare mode brings the airplane to a smooth automatic landing touchdown. The flare mode is not intended for single autopilot or flight director only operation.

Flare is armed when **LAND 3** or **LAND 2** is annunciated on the PFDs. Between approximately 60 feet and 40 feet RA altitude, the autopilots start the flare maneuver. **FLARE** replaces the **G/S** pitch flight mode annunciation.

During flare:

- At 25 feet RA altitude, the autothrottle begins retarding the thrust levers to idle
- The **PFD** autothrottle annunciation changes from **SPD** to **IDLE**
- At touchdown, the **FLARE** annunciation is no longer displayed, and the nose is lowered to the runway.

Rollout

Rollout provides localizer centerline rollout guidance. Rollout is armed when **LAND 3** or **LAND 2** is annunciated on the PFDs.

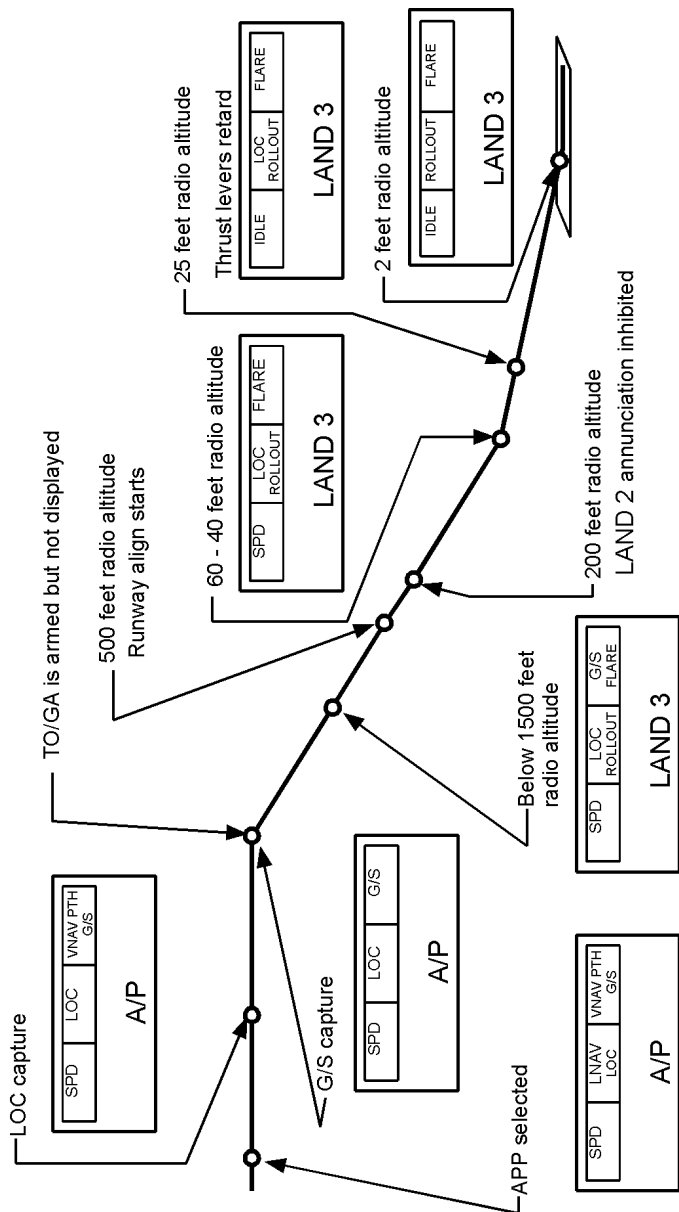
About 2 feet RA, rollout engages. **ROLLOUT** replaces the **LOC** roll mode annunciation.

The autopilot controls the rudder and nose wheel steering to keep the airplane on the localizer centerline.

During rollout, the autothrottle **IDLE** mode remains engaged until the autothrottle is disengaged.

Rollout guidance continues until the autopilots are disengaged.

AUTO FLIGHT APPROACH PROFILE



Go-Around

Go-around is engaged by pushing either TO/GA switch. The mode remains engaged even if the airplane touches down while executing the go-around. TO/GA is armed when leading edge slats are extended or the glideslope is captured.

If the flight director switches are not on, the flight director bars are automatically displayed if either TO/GA switch is pushed.

The TO/GA switches are inhibited below 2 feet RA on landing. The TO/GA switches are enabled again three seconds after radio altitude increases through 5 feet for a rejected landing or touch and go.

With the first push of either TO/GA switch:

- The PFDs display roll and pitch guidance to fly the go-around
- The autothrottle engages in thrust (THR) mode for a 2,000 FPM climb
- The AFDS maintains the ground track present at mode engagement.
- The AFDS increases pitch to hold the selected speed as thrust increases
- If current airspeed remains above the target speed for 5 seconds, the target airspeed is reset to current airspeed, (to a maximum of the IAS / MACH window speed plus 25 knots).

With the second push of either TO/GA switch:

- The autothrottle engages in the thrust reference (THR REF) mode for full go-around thrust.

TO/GA level-off:

- At the selected altitude, the AFDS pitch mode changes to altitude hold (ALT)
- If altitude is captured, or if V/S or FPA is engaged, MCP speed is automatically set to:
 - The flap placard speed minus 5 knots,
 - 250 knots if flaps are up,
 - $V_{REF} 30 + 80$ knots for engine out, or
 - A speed value entered in the IAS / MACH window after TO/GA was pushed.
- Go-around remains the engaged roll mode until another mode is selected.

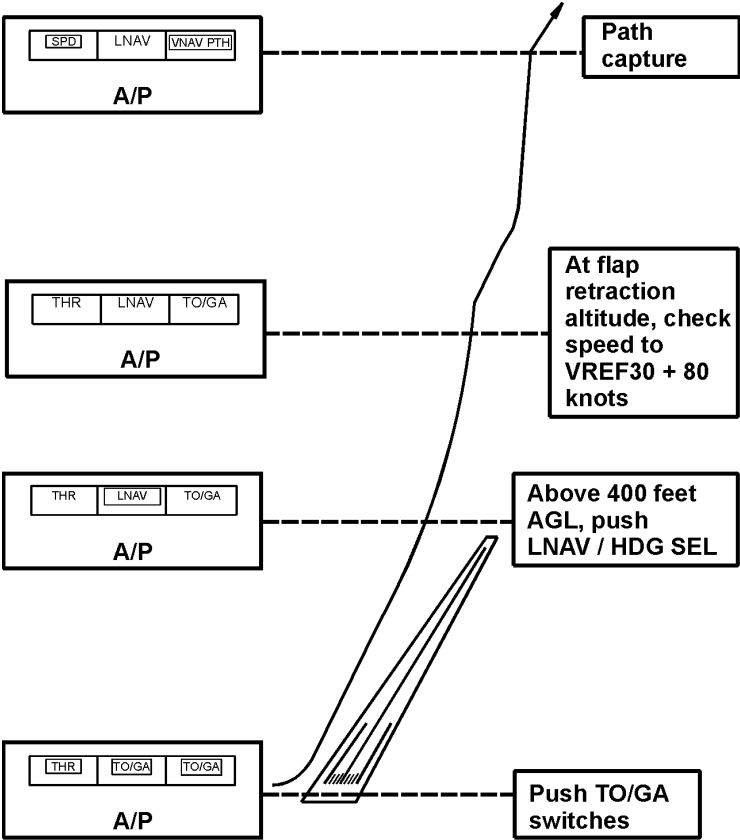
TO/GA mode termination:

- Below 400 feet RA, the AFDS remains in the go-around mode unless the autopilot is disconnected and both flight directors are turned off
- Above 400 feet RA, select a different MCP pitch or roll mode.

Note: The demonstrated altitude loss during an automatic go-around initiated below 100 feet AGL is:

GA Altitude	Altitude Loss
100 to 50 feet	27 feet
40 feet	22 feet
30 feet	20 feet
20 feet	10 feet
10 feet	5 feet

AUTO FLIGHT GO-AROUND PROFILE



Auto Flight Windshear Recovery

The AFDS provides windshear recovery guidance by means of the normal go-around pitch and roll modes. Go-around is engaged by pushing a TO/GA switch. The AFDS commands a pitch-up of 15 degrees or slightly below the pitch limit, whichever is lower.

As rate of climb increases, the AFDS transitions from pitch to airspeed control. The target airspeed is IAS / MACH window airspeed or current airspeed, whichever is greater when TO/GA is engaged. If current airspeed remains above the selected speed for 5 seconds, the selected airspeed is reset to current airspeed, (to a maximum of the IAS / MACH window speed plus 25 knots).

If the autopilot is not engaged when go-around is initiated, the pilot must fly the windshear recovery following the flight director commands. If the autothrottle is not armed, the thrust levers must be advanced manually.

Flight Envelope Protection

There are three forms of flight envelope protection in the autopilot:

- Stall protection,
- Overspeed protection, and
- Roll envelope bank angle protection.

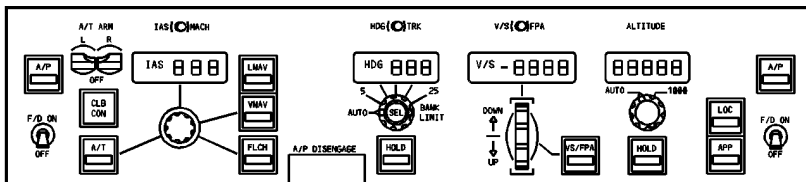
An **AUTOPILOT** caution message and roll or pitch mode failures alert the pilot if the envelope is exceeded, and the autopilot prevents further envelope violations.

Refer to Section 6.9, Flight Controls, for a description of flight envelope protection.

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CONTROLS AND INDICATORS

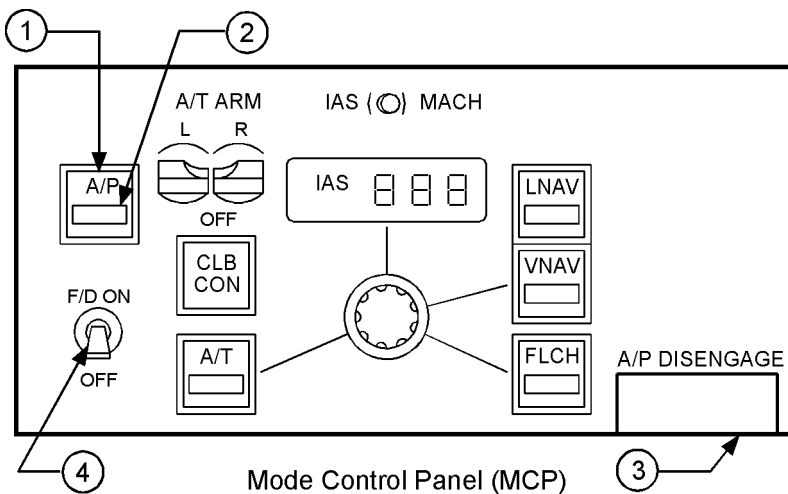
MODE CONTROL PANEL (MCP)



7779005

GLARESHIELD PANEL

Autopilot Flight Director System Controls



7779006

① Autopilot (A/P) Engage Switches (2)

Push (either switch can engage the autopilot) -

- If either flight director switch is ON, the autopilot engages in the selected flight director mode(s).
- If both flight director switches are OFF, the autopilot engages in default modes:
 - Vertical speed (V/S) or flight path angle (FPA) as the pitch mode.
 - Attitude hold (ATT) heading or track hold (HDG HLD/TRK HLD) as the roll mode.

② Autopilot Engaged Light (green)

Illuminated - All operating autopilots are engaged.

③ Autopilot (A/P) Disengage Bar

Pull down -

- Prevents autopilot engagement
- Generates EICAS advisory message **NO AUTOLAND**
- Disables bank angle protection
- Exposes the amber and black stripes
- If an autopilot is engaged:
 - It disconnects
 - Displays the EICAS warning message **AUTOPILOT DISC**
 - Sounds an aural warning
 - Illuminates the master warning lights.

Lift up -

- Permits autopilot engagement
- Hides the amber and black stripes.

④ Flight Director (F/D) Switches (2)

The left flight director switch activates the flight director steering indications (Pitch and Roll Bars) on the left PFD. The right flight director switch activates the flight director steering indications on the right PFD.

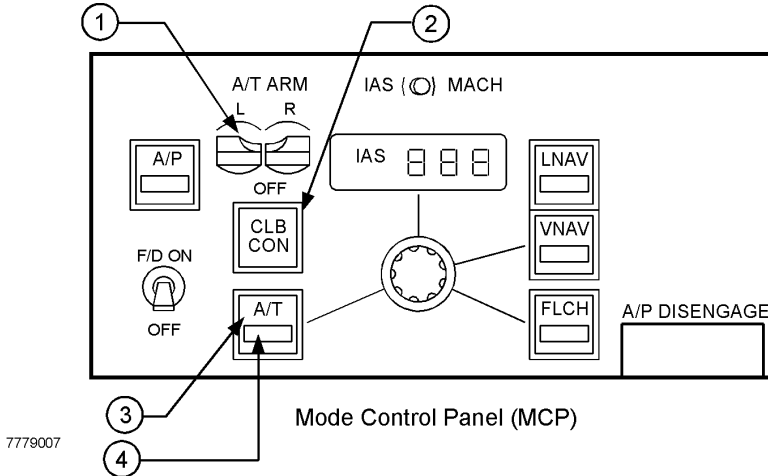
ON -

- On the ground with both flight director switches OFF, the first flight director switch positioned ON arms the flight director in the takeoff (TO/GA) roll and pitch modes, and displays the flight direction steering indications on that PFD. The flight mode annunciation (TO/GA) appears on both PFDs. Positioning the second switch ON displays the flight direction steering indications on the second PFD.
- In flight, with the autopilot disengaged and both flight director switches OFF, the first flight director switch positioned to ON engages the flight director in default modes:

- Vertical speed (V/S) or flight path angle (FPA) as the pitch mode.
- Attitude hold (ATT), heading or track hold (HDG/TRK HLD) as the roll mode.
- In flight, with the autopilot engaged and both flight director switches OFF, the first flight director switch positioned to ON engages the flight director in the currently selected autopilot mode(s).

OFF -

- The flight director steering indications are not displayed on the PFD.
- The flight director steering indications are displayed on the PFD if a TO/GA switch is pushed when airspeed is greater than 80 knots on takeoff, or on a go-around with the leading edge slats extended.



AUTOTHROTTLE SYSTEM CONTROLS

① Autothrottle (A/T) ARM Switches (2)

The left autothrottle arm switch controls the left engine autothrottle.
The right autothrottle arm switch controls the right engine autothrottle.

L and/or R - Arms the selected autothrottle for mode engagement. The selected autothrottle engages automatically when an AFDS mode (VNAV, FLCH, or TO/GA) is selected.

OFF -

- Disconnects the selected autothrottle, and
- Prevents selected autothrottle engagement.

② Climb/Continuous (CLB/CON) Thrust Switch

On the ground and below 400 feet AGL during takeoff, the switch is inoperative.

Push -

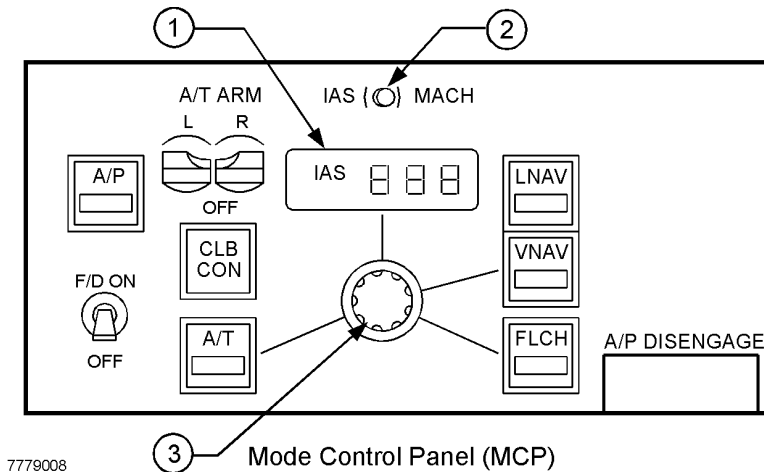
- With two engines operating, changes the engine thrust limit to the FMC selected climb thrust
- With only one engine operating, changes the thrust limit to maximum continuous (CON).

③ Autothrottle (A/T) Engage Switch

Push - Above 400 feet AGL, with the autothrottle armed, engages the appropriate autothrottle mode for the selected AFDS pitch mode, or if no pitch mode, in the speed (SPD) mode.

④ Autothrottle Engaged Light (green)

Illuminated - An autothrottle engage mode is selected.



AUTOPILOT FLIGHT DIRECTOR IAS / MACH CONTROLS

① IAS / MACH Window

Displays the speed selected by the IAS / MACH selector.

Blank when the FMC controls the speed. When changing from TO/GA to V/S, FPA, or ALT, the window automatically displays:

- The flap placard speed minus 5 knots (flaps extended)
- 250 knots (flaps up), or
- A speed value entered in the IAS / MACH window after TO/GA was pushed.

The display range is:

- 100 - 399 KIAS
- 0.40 - 0.95 MACH.

The selected speed is displayed as the PFD selected speed.

Displays 200 knots when power is first applied.

During climb, automatically changes from IAS to MACH at 0.84 MACH.

During descent, automatically changes from MACH to IAS at 310 KIAS.

② IAS/MACH Reference Switch

Push -

- Alternately changes the IAS / MACH window between IAS and MACH displays (MACH must be 0.4 or greater to switch from IAS to MACH).
- Inoperative when the IAS / MACH window is blank.

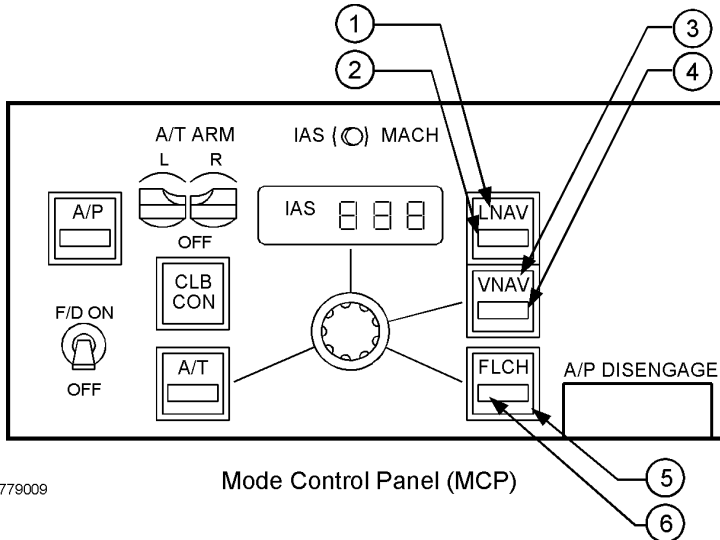
③ IAS / MACH Selector

Rotate -

- Sets the speed in the IAS / MACH window and on the PFD as the selected speed.
- Inoperative when the IAS / MACH window is blank.

Push -

- With VNAV engaged, alternately opens or closes the IAS / MACH window:
 - When the window is closed, the FMC computed target speed is active and is displayed on the PFDs.
 - When the window is open, FMC speed-intervention is active and the IAS / MACH selector may be used to set the desired speed.
- Blanks when not in SPD, FLCH, or TO/GA.



AUTOPILOT FLIGHT DIRECTOR ROLL AND PITCH CONTROLS

① Lateral Navigation (LNAV) Switch

Push -

- Arms, disarms or engages, LNAV as the roll mode.
- Displays **LNAV** in white (armed) on the PFD roll flight mode annunciator when armed. The previous roll mode remains active.
- LNAV engages if the airplane is above 50 feet radio altitude and:
 - Within 2.5 NM of the active leg
 - If not within 2.5 NM of the active leg and on an intercept heading to the active leg, remains armed then engages when approaching the active leg
 - When engaged, displays **LNAV** in green on the PFD roll flight mode annunciator.
- Selection of LNAV with the airplane not on a heading to intercept the active leg displays **NOT ON INTERCEPT HEADING** in the CDU scratch pad.
- Selection of LNAV when an active FMC route is not available displays **NO ACTIVE ROUTE** in the CDU scratchpad.

- LNAV maintains current heading when:
 - Passing the last active route waypoint
 - Passing the last waypoint prior to a route discontinuity
 - Passing the last route offset waypoint
 - Activating the inactive route or activating an airway intercept and not within LNAV engagement criteria.

LNAV (green) is disengaged:

- By selecting heading hold (HDG HOLD) or track hold (TRK HOLD)
- By selecting heading select (HDG SEL) or track select (TRK SEL)
- When the localizer captures
- If there is a dual FMC failure (LNAV may be re-engaged if there is an active CDU ALTN NAV route available).

LNAV (white) can be disarmed by pushing the LNAV switch a second time, or by arming LOC or APP.

② LNAV Light (green)

Illuminated - The LNAV mode is armed or engaged.

③ Vertical Navigation (VNAV) Switch

Push -

- Arms, disarms or engages VNAV as the pitch mode.
- Displays **VNAV** in white (armed) on the PFD pitch flight mode annunciator below 400 feet above runway elevation.
- VNAV engages 400 feet above runway elevation.
- If VNAV is selected and the FMC has insufficient data to provide VNAV guidance (such as the gross weight is invalid or there is no end-of-descent point in descent) displays **PERF/VNAV NOT AVAILABLE** in the CDU scratchpad.
- **VNAV SPD**, **VNAV PTH** or **VNAV ALT** pitch mode is displayed in green (engaged) on the PFD pitch flight mode annunciator.

- In the VNAV SPD pitch mode, the AFDS commands pitch to hold target airspeed. The autothrottle operates in the THR REF, THR, IDLE or HOLD mode, as required by the phase of flight.
- In the VNAV PTH pitch mode, the AFDS commands pitch to maintain FMC target altitude or the VNAV path. The autothrottle maintains speed.
- In the VNAV ALT pitch mode, the AFDS commands pitch to maintain the MCP selected altitude when that altitude is lower than the VNAV commanded altitude in climb or higher than the VNAV commanded altitude in descent.
- If VNAV is selected and VNAV commands a descent with the MCP altitude window above the current airplane altitude, the autopilot maintains the altitude at which VNAV was selected. When on a VNAV approach, selecting the missed approach altitude does not interfere with the VNAV descent.
- If VNAV is selected and VNAV commands a climb with the MCP altitude window below the current airplane altitude, the autopilot maintains the altitude at which VNAV is selected.
- With the VNAV ALT pitch mode engaged, the autothrottle operates in the speed (SPD) mode.
- With the VNAV PTH pitch mode engaged, the autothrottle operates in the following modes:
 - For climb or cruise - Operates in the speed (SPD) mode
 - For descent - Operates in the IDLE, HOLD, or speed (SPD) mode.
- VNAV pitch guidance is available with one engine inoperative.

VNAV (green) is disengaged:

- By engaging TO/GA, FLCH SPD, V/S, FPA, ALT or G/S pitch mode
- If there is a dual FMC failure.

VNAV (white) can be disarmed by:

- Pushing the VNAV switch a second time, or
- Arming APP.

④ **VNAV** Light (green)

Illuminated - The VNAV mode is armed or engaged.

⑤ **Flight Level Change (FLCH SPD)** Switch

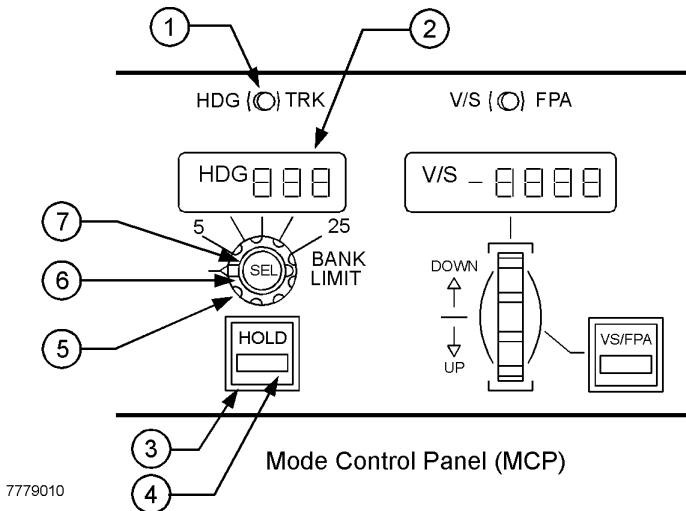
Push -

- **FLCH SPD** is displayed on the PFD pitch flight mode annunciator as the pitch mode.
- If the IAS / MACH window is blank, the IAS / MACH window opens to the FMC target speed, if valid. If not valid, the IAS / MACH window opens to the current speed.
- The thrust (THR) and pitch (FLCH SPD) modes command a climb or descent to the altitude set in the MCP altitude window at a thrust setting and vertical speed that will acquire the MCP altitude in 125 seconds.
- When changing from TO/GA to FLCH:
 - If the current speed is greater than the IAS / MACH window speed, the IAS / MACH window speed changes to the current speed.
 - If the current speed is less than the IAS / MACH window speed, the IAS / MACH window speed does not change.
- The autothrottle automatically engages:
 - For climb - Engages in THR mode; the thrust limit is CLB thrust
 - For descent - Engages in THR mode, followed by HOLD if the thrust levers reach idle.

Caution: If the thrust levers are moved more than 8° while in the THR mode the ATS mode will change to HOLD. The only way to reengage the ATS is to capture an altitude, push the thrust levers to the green N₁ limit on the EICAS or approach stall limit protection.

⑥ **Flight Level Change Light** (green)

Illuminated - The flight level change mode is engaged.



AUTOPILOT FLIGHT DIRECTOR HEADING, TRACK, AND BANK ANGLE CONTROLS

① Heading / Track (HDG/TRK) Reference Switch

Push - Alternately changes the heading / track window, PFD, and ND selected heading / track references between heading and track. Also changes the PFD roll flight mode annunciator, if the HDG or TRK mode is engaged.

② Heading / Track Window

Displays the selected heading or track.

The selected heading or track is displayed on the PFD and ND.

If approach (APP) or localizer (LOC) is armed, the heading / track in the MCP window automatically changes to the selected front course heading at LOC capture.

Displays 360 degrees when power is first applied.

③ Heading / Track Hold (HOLD) Switch

Push -

- Selects heading hold (HDG HOLD) or track hold (TRK HOLD) as the roll mode
- Displays **HDG HOLD** or **TRK HOLD** on the PFD roll flight mode annunciator
- The AFDS commands wings level and holds the heading or track established when wings level is established.

④ Heading / Track Hold Light (green)

Illuminated - The heading / track HOLD mode is engaged.

⑤ BANK LIMIT Selector (outer)

Rotate - Sets the AFDS commanded bank limit when in the heading select (HDG SEL) or track select (TRK SEL) roll mode as follows:

- AUTO - Varies between 15 - 25 degrees, depending on TAS
- 5, 10, 15, 20 or 25 - The selected value is the maximum, regardless of airspeed.

⑥ Heading / Track Selector (middle)

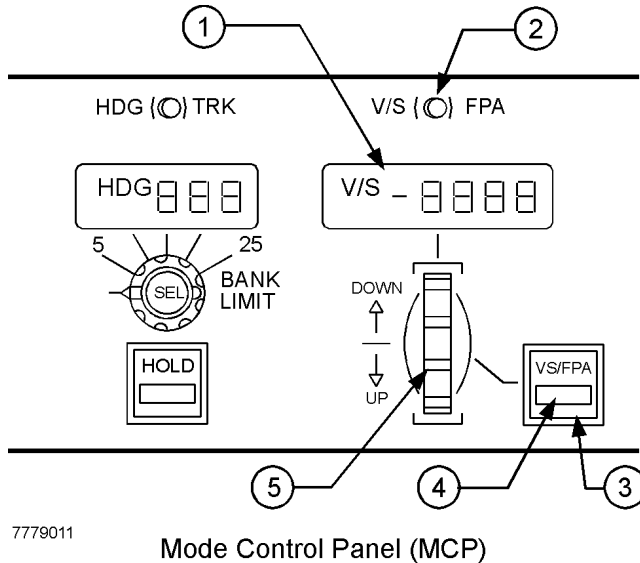
Rotate - Sets heading or track in the heading / track window and on the PFDs and NDs.

⑦ Heading / Track Select (SEL) Switch (inner)

Push -

- Selects heading select (HDG SEL) or track select (TRK SEL) as the roll mode
- Displays **HDG SEL** or **TRK SEL** on the PFD roll flight mode annunciator
- The AFDS controls roll to fly the selected heading or track
- Bank is limited by the bank limit selector.

Autopilot Flight Director Vertical Speed (V/S) and Flight Path Angle (FPA) Controls



7779011

① Vertical Speed / Flight Path Angle (V/S - FPA) Window

Displays the selected vertical speed in 100 fpm increments or the selected flight path angle in 0.1 degree increments.

The display range is:

- V/S: -8000 to +6000 fpm
- FPA: -9.9 to +9.9 degrees.

Blank when the vertical speed (V/S) or flight path angle (FPA) pitch mode is not engaged.

The selected vertical speed is displayed on the PFD vertical speed indication.

The selected flight path angle is displayed on the PFD attitude indicator.

② V/S - FPA Reference Switch

Push - Alternately changes the vertical speed / flight path angle window and PFD references between vertical speed and flight path angle. Also changes the PFD pitch flight mode annunciator, if the V/S or FPA mode is engaged.

③ V/S - FPA Switch

Push -

- Engages Vertical Speed (V/S) or Flight Path Angle (FPA) as the pitch mode.
- Displays V/S or FPA on the PFD pitch flight mode annunciator.
- Displays the current vertical speed or flight path angle in the vertical speed / flight path angle window.
- When the selected altitude is reached, the pitch mode changes to altitude (ALT).
- AFDS commands pitch to maintain the vertical speed or flight path angle displayed in the vertical speed or flight path angle window.
- If vertical speed or flight path angle is selected while in FLCH or VNAV, the autothrottle automatically engages in the speed (SPD) mode, if engaged.

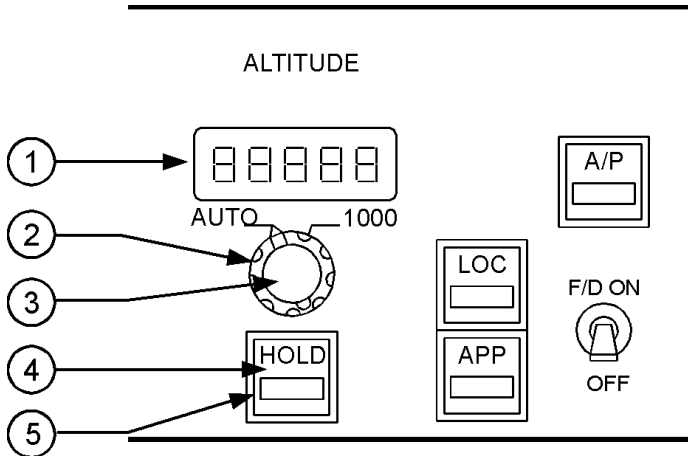
④ V/S - FPA Light (green)

Illuminated - The vertical speed or flight path angle mode is engaged.

⑤ V/S - FPA Selector

UP or DOWN - Sets the vertical speed or flight path angle in the vertical speed / flight path angle window and on the PFDs.

Autopilot Flight Director Altitude Controls



Mode Control Panel (MCP)

7779012

① Altitude Window

Displays the selected altitude.

The displayed altitude is the reference altitude for altitude alerting and level off.

The altitude range is 0 to 50,000 feet.

Displays 10,000 feet when power is first applied.

② Altitude Increment Selector (outer)

AUTO -

- The altitude selector changes in 100 foot increments
- Displays the selected BARO minimum as the selector passes through that altitude. If the BARO minimum is not a 10 foot increment, displays the next highest 10 foot increment.

1000 -

- The altitude selector changes in 1,000 foot increments.

③ Altitude Selector (inner)

Rotate - Sets the altitude in the altitude window and on the PFD altitude indication display.

Push -

- During climb or descent with altitude constraints, each push deletes the next waypoint altitude constraint between the airplane altitude and the altitude window.
- During climb with no altitude constraints, and the altitude window set above the FMC cruise altitude, the FMC cruise altitude is changed to the altitude window value.
- During cruise:
 - With the altitude window set above or below FMC cruise altitude, the FMC cruise altitude resets to the altitude window altitude.
 - If in VNAV PTH or VNAV ALT pitch mode, the airplane begins a climb or descent toward the MCP altitude window altitude (Altitude Intervention).
 - Within 50 NM of the top-of-descent (T/D) point, with the altitude window set below cruise altitude, the airplane initiates the descend now (DES NOW) feature.

④ Altitude HOLD Switch

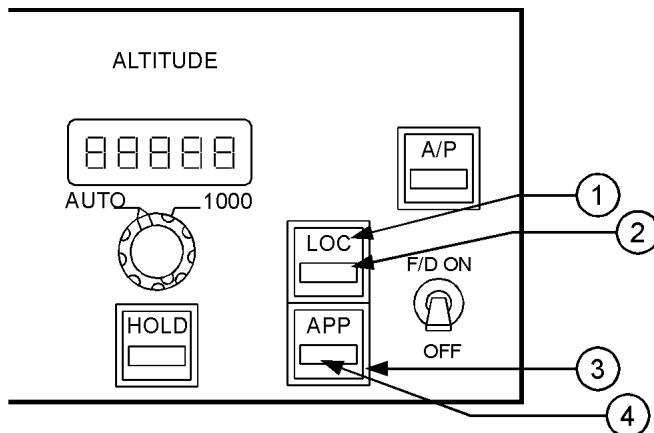
Push -

- Engages altitude (ALT) as the pitch mode
- ALT is displayed on the PFD pitch flight mode annunciator
- The AFDS commands pitch to maintain the altitude when the switch was pushed.

⑤ Altitude HOLD Light (green)

Illuminated - The altitude hold mode is engaged.

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Autopilot Flight Director Approach Mode Controls**Mode Control Panel (MCP)**

7779013

① Localizer (LOC) Switch

Push -

- Arms, disarms, engages, or disengages localizer (LOC) as the roll mode
- Displays **LOC** in white (armed) on the PFD roll flight mode annunciator before localizer capture
- Displays **LOC** in green (engaged) on the PFD roll flight mode annunciator after localizer capture
- Arms the AFDS to capture and track inbound on the front course
- The capture point varies based on range and intercept angle
- Localizer capture can occur when an intercept track angle is within 120 degrees of the localizer course.

The localizer mode can be disarmed before localizer capture by:

- Pushing the localizer switch a second time, or
- Selecting APP or LNAV mode.

The localizer mode can be disengaged after localizer capture by:

- Selecting another roll mode
- Pushing a TO/GA switch
- Disengaging the autopilot and turning both flight director switches off, or
- Pushing the localizer switch a second time above 1,500 feet radio altitude (reverts to the default roll mode).

② Localizer Light (green)

Illuminated - The localizer mode is armed or engaged.

③ Approach (APP) Switch

Push -

- Arms, disarms, engages, or disengages localizer (LOC) as the roll mode and glideslope (G/S) as the pitch mode
- Displays **LOC** and **G/S** in white (armed) on the PFD roll and pitch flight mode annunciators prior to localizer and glideslope capture
- Displays **LOC** and **G/S** in green (engaged) on the PFD roll and pitch flight mode annunciators after each one is captured
- The AFDS captures and tracks the localizer in the localizer (LOC) mode and captures the glideslope in the glideslope (G/S) mode upon interception (glideslope capture is inhibited until the localizer is captured)
- Localizer captures when the intercept track angle is within 120 degrees of the localizer course
- Glideslope captures when the intercept track angle is within 80 degrees of the localizer course and the localizer is captured.

The approach mode can be disarmed before localizer or glideslope capture by selecting APP, LOC, LNAV, or VNAV.

The approach mode disengages:

- With localizer captured and glideslope armed, by selecting another roll mode including the localizer mode (becomes a localizer approach).
- After localizer and glideslope are captured, by engaging the TO/GA mode.
- Disengaging the autopilot and turning both flight director switches OFF.
- After localizer and/or glideslope are captured, by pushing the approach switch a second time above 1,500 feet radio altitude (AFDS reverts to default pitch and roll modes).

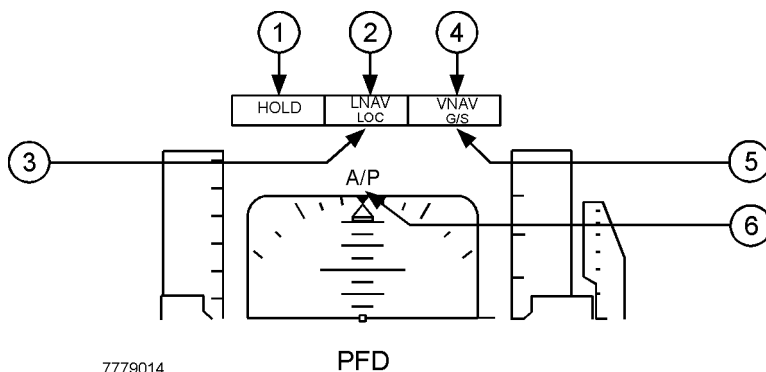
④ Approach Light (green)

Illuminated – The approach modes (LOC and G/S) are armed or engaged.

PFD Flight Mode Annunciations (FMAs)

Note: When first engaged, AFDS / autothrottle mode changes are emphasized for 10 seconds by a green ATTENTION box drawn around the mode.

Note: An amber horizontal line is drawn through the appropriate engaged pitch or roll mode when a flight mode fault is detected.



① Autothrottle Modes (Engaged)

Displayed (green) -

- THR REF
- THR
- SPD
- IDLE
- HOLD

② AFDS Roll Modes (Engaged)

Displayed (green) -

- TO/GA
- LNAV
- HDG HLD
- HDG SEL
- TRK HLD
- TRK SEL
- LOC
- ROLLOUT
- ATT

③ AFDS Roll Modes (Armed)

Displayed (white) -

- LNAV
- LOC
- ROLLOUT

④ AFDS Pitch Modes (Engaged)

Displayed (green) -

- TO/GA
- VNAV SPD
- VNAV ALT
- VNAV PTH
- FLCH SPD
- ALT
- V/S
- FPA
- G/S
- FLARE

⑤ AFDS Pitch Modes (Armed)

Displayed (white) -

- VNAV
- G/S
- FLARE

⑥ AFDS (Engaged)

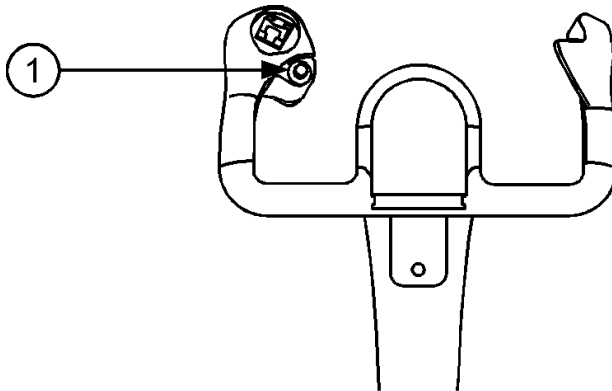
Displayed (green) -

- FLT DIR
- A/P
- LAND 2
- LAND 3

Displayed (amber) –

- NO AUTOLAND

Autopilot Disconnect Switch



7779015

CONTROL WHEEL

① Autopilot Disconnect Switches (2)

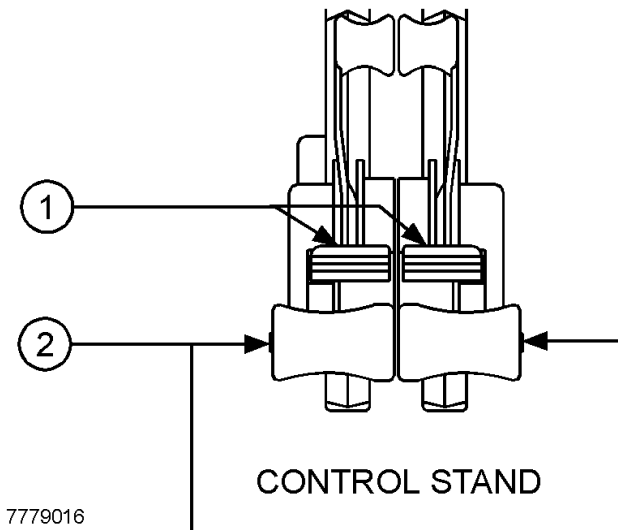
First push (either switch) -

- Disconnects the autopilot
- The master warning lights illuminate
- Displays the EICAS warning message **AUTOPILOT DISC**
- Sounds an aural warning

Note: If the autopilot had automatically disconnected, it resets the master warning lights, EICAS warning message, and the aural warning.

Second push - Resets:

- The master warning lights
- EICAS warning message
- The aural warning.

TO/GA and Autothrottle Disconnect Switches**① Takeoff / Go-Around (TO/GA) Switches (2)**

When TO/GA is armed:

On the ground (autothrottles armed and leading edge slats extended) -

- First push (either switch) below 50 knots - engages the autothrottle in THR REF mode
- The autothrottle will not engage between 50 knots and 400 feet AGL
- Pushing either switch above 80 knots disarms LNAV and VNAV.

In flight (autothrottles armed and leading edge slats extended or glideslope captured) -

- First push after takeoff - disarms AFDS modes and engages TO/GA; engages autothrottle in THR REF; any reduced thrust (D-TO) is removed and thrust limit is (TO)
- First push on approach - disarms AFDS modes and engages TO/GA; engages autothrottle in THR; thrust limit is set to command a V/S of 2,000 feet per minute climb. G/A shows as the thrust limit on EICAS
- Second push, autothrottle engages in THR REF and the thrust limit is GA.

② Autothrottle Disconnect Switches (2)

Push (either switch) -

- Disconnects the autothrottle (both left and right)
- Illuminates the master caution lights
- Displays the EICAS message **AUTOTHROTTLE DISC.**

Note: If the autothrottle had automatically disconnected it resets the master caution lights and EICAS message.

Second push -

- Resets the master caution lights and EICAS message
- The autothrottle remains armed.

Auto Flight EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
AUTOPILOT	Caution	Beeper	Autopilot is operating in a degraded mode. Engaged roll and/or pitch mode may have failed, or the autopilot has entered envelope protection.
AUTOPILOT DISC	Warning	Siren	Autopilot has disconnected.
AUTOTHROTTLE DISC	Caution	Beeper	Both autothrottles have disconnected.
AUTOTHROTTLE L, R	Advisory		Affected autothrottle is OFF or has failed.
NO AUTOLAND	Caution Advisory	Beeper	Autoland is not available. Message is a caution if fault occurs after LAND 3 or LAND 2 is annunciated, or approach has been selected but does not engage by 600 AGL. Message is an advisory if fault occurs before LAND 3 or LAND 2 is annunciated.
NO LAND 3	Caution Advisory	Beeper	Autoland system does not have redundancy for triple channel autoland. Message is a caution if fault occurs after LAND 3 or LAND 2 is annunciated. Message is an advisory if fault occurs before LAND 3 or LAND 2 is annunciated.
ALTITUDE ALERT	Caution	Beeper	When deviating by 200 feet from the MCP selected altitude.

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LIST OF EFFECTIVE PAGES

PAGE	DATE	PAGE	DATE	PAGE	DATE
TOC-1	11/01/00	30	11/01/00		
TOC-2	11/01/00	31	11/01/00		
		32	11/01/00		
* 1	11/01/01	33	11/01/00		
* 2	11/01/01	34	11/01/00		
* 3	11/01/01	35	11/01/00		
* 4	11/01/01	36	11/01/00		
5	11/01/00	37	11/01/00		
6	11/01/00	38	11/01/00		
7	11/01/00	39	11/01/00		
8	11/01/00	40	11/01/00		
9	11/01/00				
10	11/01/00	41	11/01/00		
		42	11/01/00		
11	11/01/00	43	11/01/00		
12	11/01/00	44	11/01/00		
13	11/01/00	45	11/01/00		
14	11/01/00	46	11/01/00		
15	11/01/00	47	11/01/00		
16	11/01/00	48	11/01/00		
17	11/01/00	49	11/01/00		
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20	11/01/00	51	11/01/00		
		52	11/01/00		
21	11/01/00	53	11/01/00		
22	11/01/00	54	11/01/00		
23	11/01/00				
24	11/01/00	* LEP-1	11/01/01		
25	11/01/00	* LEP-2	11/01/01		
26	11/01/00				
27	11/01/00				
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29	11/01/00				

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COMMUNICATIONS SYSTEM DESCRIPTION**INTRODUCTION**

The communication systems include:

- Cockpit voice recorder system
- Radio communication system
- Communication crew alerting system
- Interphone communication system
- Data communication system
- SELCAL system
- SATCOM system.

The communication systems are controlled using the:

- Audio control panels
- Radio tuning panels
- Control display unit (CDU) communications pages
- Multifunction display (MFD) communications.

AUDIO CONTROL PANELS

The audio control panels are used to manage the radio and interphone communication systems. Navigation receiver audio can also be monitored. The Captain, First Officer, and First Observer audio control panels are installed on the aft aisle stand.

Microphones are keyed by pushing the desired audio control panel transmitter select switch and using the MIC (microphone) position of a control wheel or audio control panel microphone / interphone switch, a glareshield MIC switch, or a hand microphone push-to-talk switch. Systems are monitored using headphones or speakers. An oxygen mask microphone is enabled and the boom microphone is disabled when the oxygen mask stowage doors are open. The oxygen mask microphone is disabled and the boom microphone is enabled when the left oxygen mask stowage box door is closed and the RESET/TEST lever is pushed.

COCKPIT VOICE RECORDER SYSTEM

The cockpit voice recorder records any transmissions from the flight deck made through the audio control panels. It also records flight deck area conversations using an area microphone. All inputs are recorded continuously.

Ground personnel may access the audio signals supplied to the cockpit voice recorder by connecting a headset to the “Cockpit Voice” jack on the P40 Service and APU shutdown panel on the nose gear strut.

RADIO TUNING PANELS

The radio tuning panels are used to tune the VHF and HF radios. The panels are designated left, center, and right, and are normally associated with the respective VHF and HF radios.

RADIO COMMUNICATION SYSTEMS

The radio communication systems consist of the very high frequency (VHF) communication system, the high frequency (HF) communication system, the satellite communication (SATCOM) system, and the selective calling (SELCAL) system.

VHF Communication System

Three independent VHF voice / data radios, designated VHF L (left), VHF C (center), and VHF R (right) are installed. Any VHF radio can be controlled by any radio tuning panel. The audio control panels are used to control voice transmission and receiver monitoring.

VHF L is configured for voice communication only. VHF C and VHF R can be configured for data or voice communication. However, only one VHF radio can operate in the DATA mode at a time. Data communication is normally selected on VHF C.

Data Mode

The DATA mode can be selected and deselected on the MFD COMM display or by pushing the frequency transfer switch on the radio tuning panel. If the selected VHF radio is the default DATA radio (selected on the MFD COMM display), then the word **DATA** is displayed in the radio tuning panel active frequency window. When a standby frequency is transferred to the active window, **DATA** is displayed in the standby window. If a new frequency is selected in the standby window when **DATA** is displayed, **DATA** is replaced by the new frequency. Data can be returned to the standby window by selecting a frequency higher or lower than the allowable VHF frequency range.

When a VHF radio is in the DATA mode, it is not available for voice communications. A VHF radio can be returned to the voice communication mode by transferring a voice frequency into the ACTIVE frequency window.

HF Communication System

There are two independent HF communication radios, designated HF L (left) and HF R (right). Each HF radio can be tuned by any radio tuning panel. HF radio sensitivity can only be set on the on-side radio tuning panel.

The audio control panels are used to control voice transmission and receiver monitoring.

When an HF transmitter is keyed after a frequency change, the antenna tunes. While the antenna is being tuned, a tone can be heard through the audio system (tuning takes a maximum of 15 seconds).

Both HF radios use a common antenna. When either HF radio is transmitting, the antenna is disconnected from the other HF radio, and it cannot be used to transmit or receive. However, both HF radios can receive simultaneously if neither is being used for transmitting.

Stuck Mic Protection

In the event an HF or VHF radio transmits for more than 30 seconds, the EICAS advisory message **RADIO TRANSMIT** is displayed. The message is removed when the transmission stops.

On the ground with both engines shut down, any VHF radio that transmits for more than 35 seconds is automatically disabled and dashes appear in the tuning panel frequency window for that radio. That radio is enabled when the microphone switch for that radio is released.

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COMMUNICATION CREW ALERTING SYSTEM

The communication crew alerting system provides aural and visual alerts for normal operations requiring crew awareness that may require crew action. Visual alerts are presented as EICAS messages preceded by a bullet symbol (•). The aural alert is a high-low chime. The following table shows communication crew alert categories and the respective aural and visual alerts for each category.

Crew Alert Categories

Communication Crew Alert Category	Aural Alert	Visual Alert	Comments
High	High-low chime	Communication EICAS alert	None currently implemented. Reserved for future use.
Medium	High-low chime	Communication EICAS alert	Message awareness required. Crew action may be required.
Low	None	Communication EICAS alert	Crew action may be required.

Communications Alert Messages

Crew Communications

EICAS Communication Message	Alert Level	Condition	Crew Action
• CABIN ALERT	Medium	Pilot alert received over cabin interphone.	Respond to the alert.
• CABIN CALL	Medium	Pilot call received over cabin interphone.	Respond to the call.
• CABIN READY	Medium	CABIN READY received over cabin interphone.	Crew awareness. Automatically removed after one minute.
• GROUND CALL	Medium	Pilot call received over flight interphone from nose wheel well.	Respond to the call.

Data Link

EICAS Communication Message	Alert Level	Condition	Crew Action
• COMM	Medium / Low	A data link message has been received.	Select COMM display on the MFD.
• COMM BUSY	Medium	Communications system pending data link message queue is full.	Respond to current pending data link messages.
• FMC	Medium	An FMC related data link message has been received.	Select FMC from the CDU MENU page if not already in the FMC mode. View the message title in the CDU scratchpad. View the message on the appropriate CDU page.
• PRINTER (with data link installed)	Medium / Low	A data link message has been received and sent to the printer.	Review the printed message.
• ATC	Medium	An ATC data link message has been received or an armed report has been sent.	Respond to message displayed on EICAS or select the MFD communications display.
• DATALINK AVAIL	Low	A lost data link connection has been re-established.	Resume use of data link communication.

SATCOM

EICAS Communication Message	Alert Level	Condition	Crew Action
• SATCOM MESSAGE	Medium / Low	SATCOM voice system information available if SATCOM system is selected on a CDU.	View the SATCOM CDU message.

SELCAL

EICAS Communication Message	Alert Level	Condition	Crew Action
• SELCAL	Medium	SELCAL received or any SATCOM voice call received.	Respond to the call.

SELECTIVE CALLING (SELCAL) SYSTEM

The SELCAL system monitors the three VHF radios and the two HF radios. When the system receives a call from a ground station, the crew is alerted through the communication crew alerting system.

SATELLITE COMMUNICATION (SATCOM) SYSTEM

The SATCOM system provides both voice and data communications. Any Data messages down linked or up linked through Flight Deck Comm are first attempted via VHF. SATCOM is then selected automatically where VHF is unavailable.

The aircraft contains a Beam Steering Unit, mounted in the top of the fuselage which logs on to the appropriate satellite and keeps it in view as the aircraft moves. This Beam Steering Unit accepts position and ground speed inputs from the ADIRU so as to remain logged on to the satellite.

The voice or data communication link between the aircraft and the satellite is in the VHF spectrum and therefore line of sight. Once this link between the aircraft and the satellite is established, a ground gateway called a GES, or Ground Earth Station, becomes the relay point for the call as it is connected to the public telephone network.

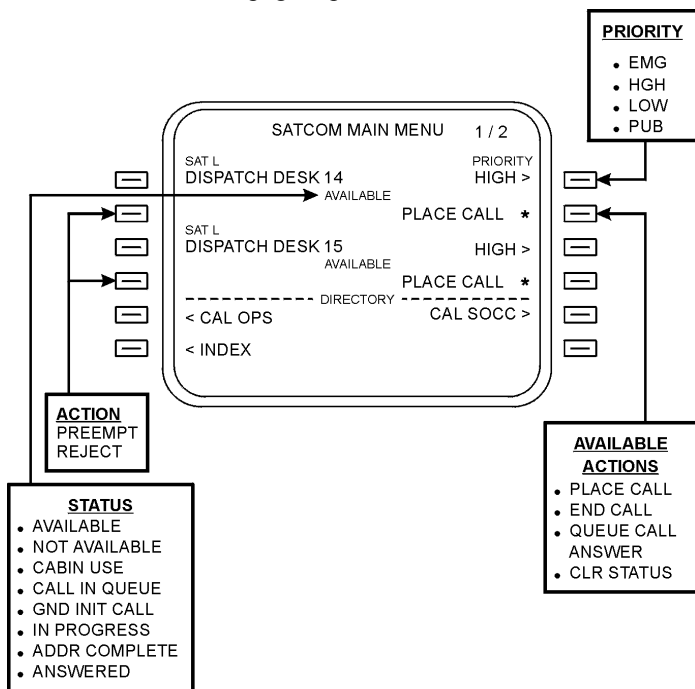
A Communications Service Provider contracts with Continental to provide Satellite voice and data communications. Each Service Provider owns, or leases space on a GES to provide the service to its user / customers.

When placing a call via SATCOM, the crew does not have to select a GES unless it is experiencing trouble. GES selection is automatic and dependent on the location of the aircraft and the Service Provider contracted with.

SATCOM voice is set up via any one of the three CDU's and connected through the Audio Control Panel SAT microphone selectors. The Flight Deck handset is not connected to the SATCOM system. All SATCOM voice communications are facilitated through the boom or hand microphone, and headsets or speaker audio.

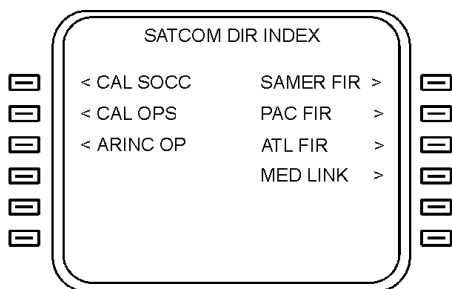
There is no dedicated SATCOM voice channel for the Flight Deck. There are six channels installed on the aircraft, 5 voice and 1 data channel. The Flight Deck can use up to two voice channels, simultaneously if desired. If all five voice channels are in use by the cabin, a busy signal will be audible when SAT 1 or SAT 2 is selected on the audio selector panel. On the SATCOM MAIN MENU page the crew may select **QUEUE CALL** to wait for an available channel (LSK 2L), or **PREEMPT*** (LSK 2R) to drop a voice channel in use and immediately initiate a call. The **PREEMPT*** prompt is only available when the priority is set to **HGH**, which is the default value for all Flight Deck initiated calls.

- To access the SATCOM system and place a voice call, the MENU key is selected on any CDU.
- < SAT is selected from the available prompts.
- The SAT MAIN MENU page is presented below.



77710099

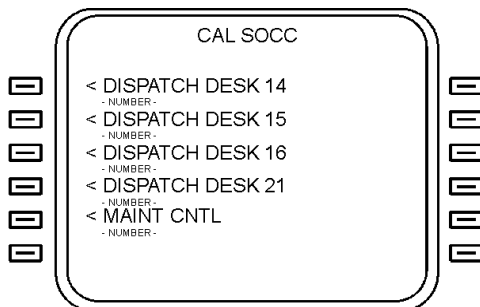
- The CAL OPS and CAL SOCC sub-directories may be accessed directly from the SATCOM MAIN MENU page.
- All other sub-directories may be accessed from the index prompt at LSK6L.



77710092

- CAL SOCC = Dispatch or Maintenance Control
- CAL OPS = Continental Station Operations
- ARINC OP = ARINC Relay Radio Service
- SAMER FIR = South American Flight Identification Regions; ATC sectors.
- PAC FIR = Pacific Flight Identification Regions.
- ATL FIR = Atlantic Flight Identification Regions.
- Med Link = CAL MEDLINK contractor for in-flight medical emergencies.

All the above sub-directories are not displayed here, however, a representative sample of two selected sub-directories are presented below.



77710093

ATL FIR1 / 3

< ACCRA
- NUMBER -

< BERLIN
- NUMBER -

< BORDEAUX * EMERG
- NUMBER -

< BREMEN
- NUMBER -

< BREST * EMERG
- NUMBER -

< BRINDISI
- NUMBER -

BRUXELLES >
- NUMBER -

DUSSELDORF >
- NUMBER -

FRANKFORT >
- NUMBER -

GANDER OCNC * EMERG >
- NUMBER -

GANDER * EMERG >
- NUMBER -

KHABAROVSK >
- NUMBER -

77710094

Caution: FIR numbers with a *EMERG suffix are only to be used for non-normal / emergency communications.

- Upon line selection of one of the above prompts on an available SATCOM channel, a PLACE CALL* prompt will be provided. When PLACE CALL* is selected, the call process is started and may take from 15 to 45 seconds, or more to connect. A typical telephone style ring will be audible in the headset or speaker as the call is connected and the phone being called rings. When the party called answers, normal two way communications can be accomplished as in a ground to ground call from any telephone.
- CAL SOCC can conference in a number of calls to anywhere in the world if necessary.
- To terminate a call in progress, select END CALL > to hang up.
- If the party on the ground hangs up, the call is terminated.

A priority system has been established by the SATCOM networks. The priority for all Flight Deck originated calls defaults to **Operational High**. Other priorities are:

- Operational Low: Passenger service communications by the crew.
- Public: Passenger calls.
- Priority 1: EMERGENCY – SAFETY OF FLIGHT.

Note: Priority 1 – EMERGENCY (EMG >) is crew selectable on the CDU, and should only be used during a valid emergency. Selection of Emergency priority while placing a SATCOM call will activate alarms in the associated Ground Earth Station who will call CAL SOCC. Selecting Emergency will also preempt a cabin call in progress and provide a clear channel immediately.

SELCAL

EICAS Communication Message	Alert Level	Condition	Crew Action
• SELCAL	Medium	SELCAL received or any SATCOM voice call received.	Respond to the call.

Selective Calling (SELCAL) System

The SELCAL system monitors the three VHF radios and the two HF radios. When the system receives a call from a ground station, the crew is alerted through the communication crew alerting system.

INTERPHONE COMMUNICATION SYSTEM

The interphone communication system includes the:

- Flight interphone system
- Service interphone system
- Cabin interphone system
- Passenger Address (PA) system.

The flight interphone, service interphone, and passenger address systems are normally operated through the audio select panel. The cabin interphone is operated through the CDU or the flight deck handset.

Flight Interphone System

The flight interphone system provides communications on the flight deck and between the flight deck and the ground crew through the flight interphone jack on the APU ground control fire protection panel in the nose landing gear wheel well.

The system is used by selecting the INT (interphone) position of a control wheel or audio control panel mic / interphone switch. The interphone can also be used by selecting the FLT transmitter selector on an audio control panel and then selecting one of the following microphone switches:

- MIC position of a control wheel switch
- MIC position of an audio control panel mic/interphone switch
- A hand microphone push to talk switch
- A glareshield MIC switch.

Crew alerting of a ground crew initiated call is provided by an aural alert chime, the **GROUND CALL** EICAS communications alert message, and a **CALL** light illuminated on the audio control panel transmitter select switch.

Service Interphone System

The service interphone system provides voice communications between ground crew stations at various locations around the airplane. The system can be connected to the flight interphone system through the service interphone switch on the overhead panel.

Passenger Address System

The Passenger Address (PA) system is used by the flight crew to make cabin announcements. Pushing a PA transmitter select switch on an audio control panel and activation of a microphone switch provides direct access to all PA areas.

The system is monitored by pushing the PA receiver volume control on an audio control panel. The PA system can also be selected through the cabin interphone system or the flight deck handset.

Cabin PA announcement priorities are:

1. Flight deck announcements from an audio control panel
2. Cabin handset direct access announcements
3. Priority (all area) announcements
4. Normal announcements from flight attendant or flight deck handsets.

Cabin Interphone System

The cabin interphone system provides voice communications between the flight deck and the flight attendant stations. Boom microphones, oxygen mask microphones, and hand microphones are used by selecting the CAB (cabin) transmitter select switch on an audio control panel and pushing the mic / interphone switch to the MIC position. Cabin interphone station(s) must be selected and a call initiated to alert the desired station to pick up the call.

EICAS communications alert messages and chimes alert the pilots to incoming cabin calls. Normal priority calls from the cabin display the **CABIN CALL** EICAS communications alert message.

Priority calls from the cabin display the CABIN ALERT EICAS communications alert message. Priority calls automatically disconnect lower priority cabin interphone calls. Priority calls placed while a priority call is in progress are automatically connected as a conference call.

The cabin interphone call queue, speed dial numbers, and directories are accessed from the center CDU cabin interphone menu.

Calls are initiated by:

- Line selecting the call location on the CDU display, or
- Entering the appropriate call code in the CDU scratchpad and selecting SEND.

Pushing the audio control panel CAB (cabin) transmitter select switch twice within one second places a priority call to Door 1 Left.

A station which is in use will be disconnected from the call in progress and connected to the flight deck.

Note: Flight deck initiated calls will not interrupt a current PA announcement from the dialed station.

Calls can be answered by selecting an audio control panel CAB transmitter select switch or, if a CAB transmitter select switch is already pushed in, by pressing a mic / interphone switch to the MIC position.

Calls can be ended by selecting the CDU prompt END CALL or de-selecting the CAB transmitter selector on the audio control panel. The call also ends if the other party terminates the call.

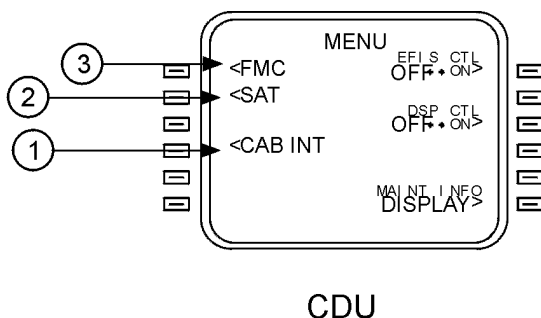
Calls can also be answered or placed using the flight deck handset. Desired call locations are entered using the numeric keys on the handset. Pressing the handset reset switch or placing the handset back on the cradle terminates the call.

Note: The handset PA push-to-talk switch is not required to operate the handset except for PA announcements.

CDU Menu Page

Pushing the CDU MENU key displays the CDU menu page.

Normally, the cabin interphone (CAB INT) and SATCOM (SAT) displays are viewed on the center CDU. The SATCOM prompt is available on all CDUs.\



77710000

① CAB INT

Push - Displays the SPEED DIAL page and provides a < DIRECTORY prompt for sub-directory access.

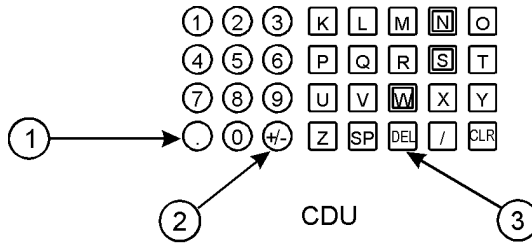
Note: Available only on the center CDU.

② SAT

Push - Displays the CDU SATCOM pages.

③ FMC

FMC not displayed on center CDU if both left and right CDU are operational.

Cabin Interphone CDU Controls

77710001

① Period (.) key

Push - Displays an asterisk (*) in the scratchpad.

② Plus/Minus (+/-) Key

Push - Displays a pound sign (#) in the cabin interphone scratchpad.

③ Delete Key

Push -

- Displays **DELETE** in the cabin interphone scratchpad
- Used to delete calls from the call queue.

Cabin Interphone Main Menu

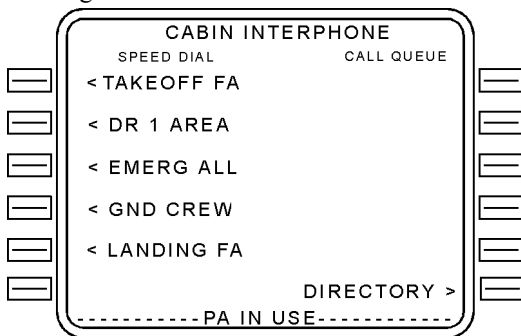
The cabin interphone menu allows the pilots to send or end calls. Calls are sent by selecting a station from the speed dial page or the directory. Two digit station codes can be manually entered into the scratchpad and the call sent using the SEND prompt. A list of the two digit station codes is located on the handset.

Speed Dial

The speed dial menu provides a quick means to call up to five pre-defined stations or group of stations. A single push initiates the selected call.

The speed dial menu is selected from the CABIN INTERPHONE prompt on the MENU page. There are five selections:

1. TAKEOFF FA: This selection at LSK 1L is used to activate the automated takeoff announcement, "FLIGHT ATTENDANTS PLEASE BE SEATED FOR DEPARTURE." PA IN USE will appear above the scratch pad during this announcement.
2. DR 1 AREA: This selection of LSK 2L will ring the interphone at cabin doors 1 left and 1 right.
3. EMERG ALL: Selection of LSK 3L will ring all the interphone stations in the cabin with four HI LO Chimes and steadily illuminate the overhead pink call lights at each cabin door.
4. GND CREW: Selection of LSK 4L will activate the nose wheel well horn to alert the ramp crew the flight deck wishes to speak with them.
5. LANDING FA: The selection of LSK 5L is used to activate the automated landing announcement, "FLIGHT ATTENDANTS PLEASE BE SEATED FOR ARRIVAL." PA IN USE will appear above the scratch pad during this announcement.



Call Queue

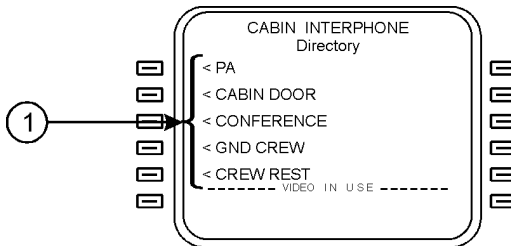
When the flight deck is involved in a call, additional incoming calls are displayed in the queue. Up to four calls can be displayed in order of the priority assigned as follows:

- Pilot Alert
- Conference calls
- Cabin calls
- Other calls.

The Pilot Alert queue entry is displayed only when the flight deck is using the PA and an incoming call is received.

When there are four calls in the queue and a new, higher priority call is received, the lowest priority call is removed from the queue and the new call is displayed in the proper priority.

Cabin Interphone Main Menu Page



7775305

① Cabin Interphone Sub-Directories

Lists the dial code labels of predefined stations, station groups, or functions:

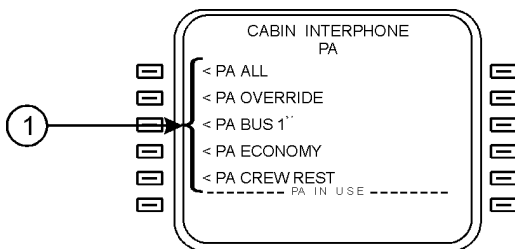
- PA CALL - Selects PA directory
- CABIN DOOR - Selects Door directory
- CONFERENCE - Selects conference call options
- GND CREW – Selects Ground Crew call page
- CREW REST – Selects Crew Rest interphone page.

Push - Directly dials the selected station, station group or enables the selected call function.

Cabin Interphone Directory Page

The cabin interphone directory pages are used to access subdirectory pages. CDU cabin interphone directory pages and individual directory entries are predefined by the airline. Each directory label is the name of a subdirectory where the dial code labels of the individual stations or functions are listed.

Selection of the specific location(s) is accomplished on the subdirectory page.



7775307

① CAB INT PA

A flight deck PA to any one of 5 areas can be made from this subdirectory.

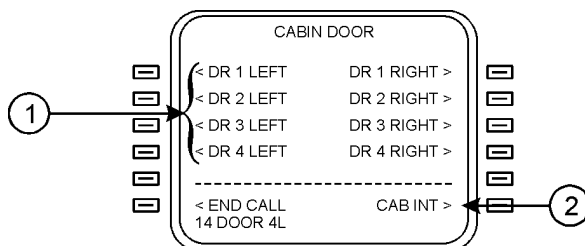
Cabin Interphone Subdirectory Page

Selecting a dial code label on the subdirectory page initiates a call to that station or station group.

The cabin interphone subdirectory pages are used to view and select individual locations through their dial code labels.

Typical stations or station groups are:

- Individual cabin station
- Two or more cabin stations for conference calls
- PA call to all cabin areas
- PA call to individual cabin areas
- PA priority call to all cabin areas
- Ground crew alert



7775308B

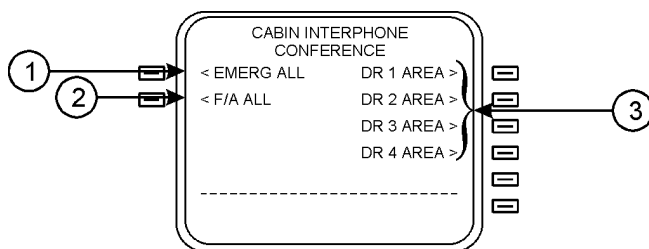
① Dial Code Labels

Push - Initiates a call to the appropriate station(s).

② CAB INT

Push - Returns the display to the cabin interphone main menu page.

Cabin Interphone Conference Page



7775308C

① EMERG ALL

Sounds one HI-LO chime and illuminates all cabin interphone stations.

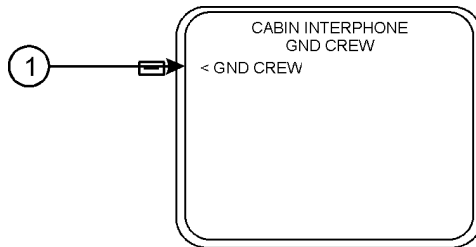
② F/A ALL

Sounds one HI-LO chime and illuminates all cabin interphone stations.

③ DR X AREA

Selections sound one HI-LO chime and illuminate all the respective handset call lights in that door area.

Cabin Interphone Ground Crew Page

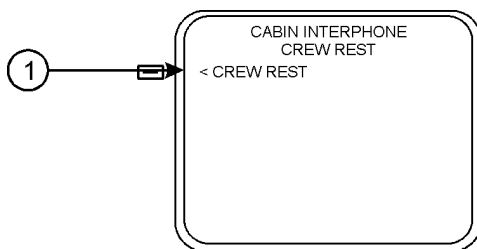


7775308D

- ① GND CREW

Ground Crew call sounds one aural horn in wheel well with each selection.

Cabin Interphone Crew Rest Page



7775308E

① CREW REST

Crew Rest will connect the Flight Deck with the pilot Crew Rest interphone.

MFD COMMUNICATIONS FUNCTIONS

Introduction

The MFD communications functions are used to control data link features. Data link messages not processed by the FMC are received, accepted, rejected, reviewed, composed, sent, and printed using communications functions on the MFD. Data link communications can be established with participating ATC and company locations. ACARS and data link radio management functions are provided through communications management menus.

The display select panel communication (COMM) display switch displays the communications main menu on the selected multifunction display (MFD). Communications functions are selected using the cursor control device. Message text entry is accomplished by entering data into the CDU scratchpad and transferring it to the appropriate area. Messages can be printed on the flight deck printer. Incoming message traffic is annunciated by EICAS communications messages.

Illustrations shown in this section depict the COMM menu with all features enabled. ATC data link requires appropriate airplane and ATC capability. FLIGHT INFORMATION descriptions are not included.

Communications Menus

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
MENU HEADING LINE		
MENU/DATA AREA		
		EXIT MENU

MFD

Note: Shown with all menu functions active.

77710005

The COMPANY menu is basically an ACARS menu known as Flight Deck Comm. It is customized by Continental to provide maximum flexibility to the crew in obtaining flight information such as weather, block and flight times, information from Dispatch or Maintenance Control, and the ability to send status reports on ETA, holding, diversions, delays and other information. ACARS can communicate data over either VHF or SATCOM.

NEW MESSAGES display messages up linked that have not yet been reviewed. Once reviewed, these messages move to the REVIEW category.

REVIEW provides the means to review previously up linked company or ATC messages. The messages in REVIEW have a time stamp included.

ATC pages provide the means to LOG ON to an ATC facility equipped to participate in CONTROLLER PILOT DATA LINK COMMUNICATIONS, (CPDLC).

The MANAGER category enables/disables control of ACARS, Data frequencies, ADS functions, Data Link Reset, SATCOM and VHF logs and other functions.

FLIGHT INFORMATION is not an active function at this printing. It is reserved for Air Traffic Service (ATS) functions such as Digital ATIS, Clearance Request functions and Tower weather updates provided via a message protocol not yet enabled on the B777.

Selectable menu items (active functions) have white text on a gray background. Inhibited items have cyan text on a black background with a cyan border. Inhibited items cannot be selected. The background color for a selected top level function is green.

Selecting ATC, FLIGHT INFORMATION, COMPANY, REVIEW, MANAGER, or NEW MESSAGES selection:

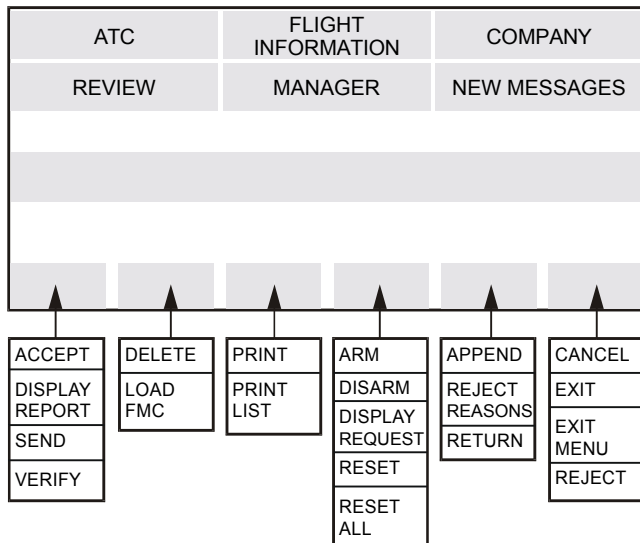
- Places the appropriate title in the menu heading line
- Displays the subordinate menu selections for that function in the menu / data area.

Subordinate menu items which lead to subsequent subordinate menu(s) are followed by three dots (...). Making a selection from the subordinate menu places the title of that function in the menu heading and displays a new subordinate menu or data.

Communications Control and Input Functions

Communications menus, controls, and data input methods are similar for ATC, FLIGHT INFORMATION, and COMPANY functions. Basic functions are explained here.

Command Key Locations



77710006

Communications command keys are displayed at the bottom of communications pages. Command keys change as appropriate for pages displayed. Each key has a label which changes based on the page displayed and the possible action. Only one label is displayed in a single location for a specific condition on the page.

Command Key Functions

The following table describes the key functions and labels for all COMPANY and ATC functions.

Command key label	Displayed/Inhibited	Key function
ACCEPT (uplink messages)	<p>Displayed when:</p> <ul style="list-style-type: none"> • Message requires an accept / reject response, and • All message pages have been displayed. <p>Inhibited for first 2 seconds of message display.</p>	<p>Select:</p> <ul style="list-style-type: none"> • Message acceptance downlinked to message sender • ACCEPT & REJECT keys removed • Message status displayed in info box • CANCEL command key displayed.
APPEND (company downlink accept / reject response)	<p>Displayed when:</p> <ul style="list-style-type: none"> • All pages of the uplinked message have been displayed, and • Company data link capability is operational. <p>Inhibited when:</p> <ul style="list-style-type: none"> • For first 2 seconds of uplink display, or • When company data link capability is not operational. 	<p>Select:</p> <ul style="list-style-type: none"> • Uplink message is removed, and • Downlinked message page is displayed.
ARM (ATC downlink reports)	<p>Displayed when an armable report is open:</p> <ul style="list-style-type: none"> • REPORT LEAVING • REPORT LEVEL • REPORT PASSING • REPORT REACHING. 	<p>Select:</p> <ul style="list-style-type: none"> • Arms the report for automatic downlink to ATC when report conditions are met • Key function changes to DISARM • Report status changes from OPEN to ARMED.

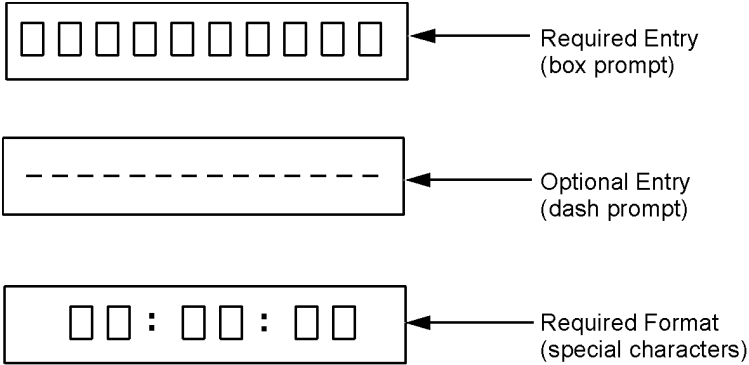
Command key label	Displayed/Inhibited	Key function
CANCEL	<p>Displayed when:</p> <ul style="list-style-type: none"> • Uplink message is displayed which does not require an accept or reject response, or • An uplink message is displayed which has been accepted, rejected, or • Review message is displayed. <p>Inhibited for first 2 seconds of message display.</p>	Message is removed.
DELETE (ATC reports)	Displayed when a downlink report page is open for entry.	<p>Select:</p> <ul style="list-style-type: none"> • Deletes the report without sending • Displays the COMM menu.
DISARM (ATC reports)	<p>Displayed when an armable report is ARMED:</p> <ul style="list-style-type: none"> • REPORT LEAVING • REPORT LEVEL • REPORT PASSING • REPORT REACHING 	<p>Select:</p> <ul style="list-style-type: none"> • Disarms automatic report downlink to ATC • Key function changes to ARM • Report status changes from ARMED to OPEN.
DISPLAY REPORT	Displayed after accepting an uplink message which contains a report.	Displays the downlink report attached to an uplinked message.
DISPLAY REQUEST	Displayed after accepting an ATC uplink message which contains a request.	Downlink request which required an ATC response is displayed.
EXIT	<p>Displayed when:</p> <ul style="list-style-type: none"> • A downlink message is displayed or • A manager page is displayed. 	COMM main menu is displayed.

Command key label	Displayed/Inhibited	Key function
EXIT MENU	Displayed when menu is displayed.	COMM main menu is displayed.
LOAD FMC (ATC uplink)	Displayed when uplinked ATC message contains data which can be loaded into the FMC. Inhibited when active route is in a MOD condition.	Select: <ul style="list-style-type: none"> • FMC data is transferred into the active route and • FMC modification is started.
PRINT	Displayed when: <ul style="list-style-type: none"> • Displayed message can be printed and • Printer is available. Inhibited when printer is not available.	Message is sequenced for printing.
PRINT LIST	Displayed when: <ul style="list-style-type: none"> • New message list page is displayed or • Review list page is displayed. Inhibited when printer is not available.	All messages in the list are sequenced for printing.
REJECT (uplink messages)	Displayed when: <ul style="list-style-type: none"> • Message requires an accept / reject response and • All message pages have been displayed. Inhibited for first 2 seconds of message display.	Select: <ul style="list-style-type: none"> • Message rejection downlinked to message sender • ACCEPT and REJECT command keys removed • CANCEL command key displayed • Message status displayed in info box, and • Message cleared from the display 5 seconds after status changes to REJECTED.

Command key label	Displayed/Inhibited	Key function
REJECT REASONS (ATC reject downlink)	Displayed when an uplink message requires an accept or reject response.	Displays REJECT REASON page.
RESET (downlink pages)	Displayed when downlink page is displayed.	Message parameters are reset to their default values.
RESET ALL (ATC downlink pages)	Displayed when ATC VERIFY REQUEST page is displayed.	Select: <ul style="list-style-type: none"> • All request parameters on the VERIFY REQUEST are set to reset / default values • ATC combined request pages are reset, or • COMM main menu is displayed.
RETURN	Displayed when: <ul style="list-style-type: none"> • A review message is displayed, or • A downlink message is displayed, or • A VERIFY REQUEST page is displayed, or • A manager page is displayed. 	Previous list page, request page, or menu is displayed.
SEND (downlink messages)	Displayed when: <ul style="list-style-type: none"> • Required data complete and • All company message pages have been displayed. Inhibited when transmission queue is full.	Select: <ul style="list-style-type: none"> • Message transmission initiated, • Message status displayed in info box, and • Message cleared from the display 5 seconds after status changes to SENT.

Command key label	Displayed/Inhibited	Key function
STANDBY (ATC uplink messages)	Displayed when: <ul style="list-style-type: none">• Uplinked message is received which requires an accept / reject response, and• STANDBY has not been previously selected for this message.	Standby response is sent.
VERIFY	Displayed when data is entered on more than one of the following ATC pages: <ul style="list-style-type: none">• ALTITUDE REQUEST• ROUTE REQUEST• SPEED REQUEST.	Displays VERIFY REQUEST page.

INTENTIONALLY LEFT BLANK

Text Entry

77710007

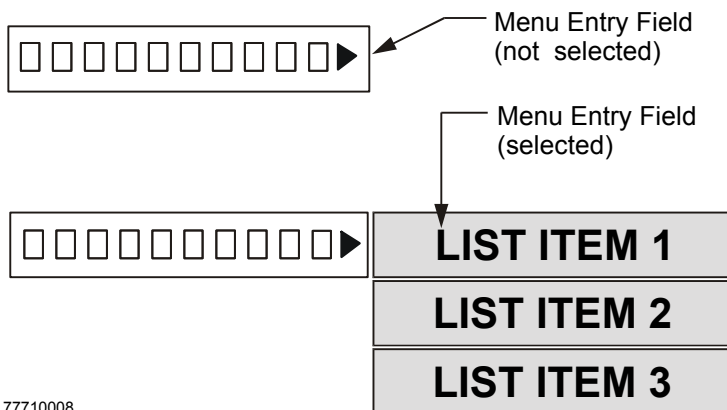
Downlink message pages provide text entry fields. Scratchpad entries transfer to selected entry fields when a cursor select switch is pushed. Scratchpad entries blank when successfully transferred. Scratchpad entries remain and an INVALID ENTRY message is displayed on the MFD when the entry is not valid.

An entry field resets to a default value when a blank scratchpad is transferred. An entry field blanks when a space is transferred. An entry field resets to the default entry prompt when DELETE is transferred.

Box and dash prompts indicate the maximum number of characters allowed.

Some entry fields have format requirements. Entry prompts display the required entry format, with special characters separating entry boxes. The required data is entered without the special characters or spaces. Scratchpad data is transferred to entry boxes after being checked for proper format. Invalid data or format prevents transfer and displays an INVALID ENTRY message.

Menu Entry Fields



77710008

Menu entry fields are used to make text entry selections from a list. Menu entry fields distinguish mandatory versus optional entry in the same manner as CDU entry field.

The menu entry field is distinguished from other entry fields by the pointer to the right of the field.

When initially selected, a list of menu items is displayed to the side of the pointer. If an item from the list is then selected using the cursor and cursor select switch, that item is transferred to the entry field. If the menu prompt is selected again and the CDU contains a valid value, that CDU value is transferred to the entry field. Actions for invalid values, an empty scratchpad, space characters, and the delete key are the same as for the CDU entry field. When the entry field is selected with text already inserted, the menu list is removed from the display.

Invalid Entries

When the scratchpad contains invalid data for the entry field, the INVALID ENTRY message is displayed in the INFO BOX. Re-entering valid data clears the INVALID ENTRY message on an ATC downlink page. Selecting the EXIT INFO key also clears the INVALID ENTRY message and removes the info box.

INVALID ENTRY messages on a company downlink page must be individually cleared by selecting the EXIT INFO key before valid data is re-entered into the field.

Message List

Message titles and related information can be displayed in a list. The illustration shows the REVIEW message list. A similar list is available for NEW MESSAGES.

The NEW MESSAGE list is sorted by the time of receipt, the most current message at the top. ATC uplink messages have an ATC label to the right of the message block. The message remains in the list until it is accepted, rejected, or displayed. Messages requiring an accept / reject remain in the list until the accept/reject response is accomplished.

Selecting an item from the list with the cursor and pushing the cursor select switch displays the message page. Lists are also used to view new messages.

ATC		FLIGHT INFORMATION	COMPANY
REVIEW		MANAGER	NEW MESSAGES
① →	1848Z		RECEIVED → ③
② →	1842Z	VHF-VOICE CONTACT	ACCEPTED
	1832Z	WEATHER	DISPLAYED ← ④
	1820Z	ATIS	DISPLAYED

77710009

① Current Time

Displays current time.

② Message Time

For new messages - Time the message is received.

For review messages - Time the message is received or sent.

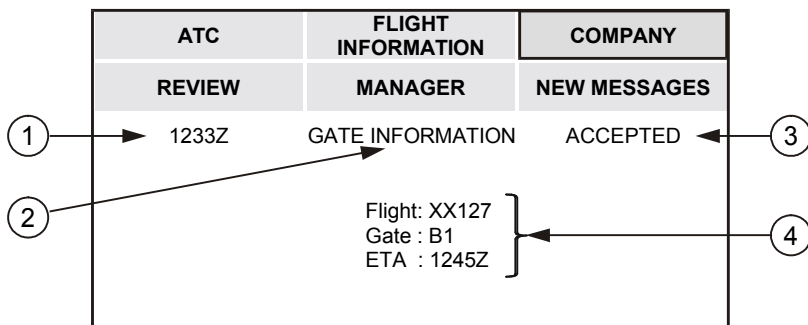
③ Message Title

Displays message title information.

④ Message Status

Only displayed for review list boxes.

The appropriate status indicator is displayed.

Message Display Format

77710010

A typical message display format is shown. Messages selected from a list are displayed in this format.

Note: Selection of a main menu item exits the message page.

① Message Time

For downlink messages - current time.

For new messages - time the message is received.

For review messages - time the message is received or sent.

② Message Title

Displays message title information.

③ Review State

Only displayed for review messages.

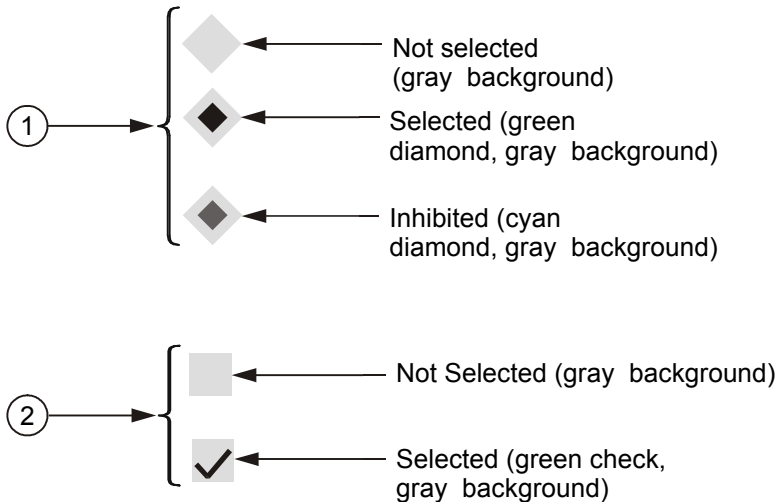
The appropriate state indicator is displayed.

④ Message Content

Located between the title and the keys.

Exclusive and Nonexclusive Select Keys

Manager and new message pages can contain select keys to activate features. Pushing the cursor select switch when the key is highlighted makes the selection. A second selection of a nonexclusive key toggles to the deselected state.



777100011

① Exclusive Select Key

The diamond-shaped exclusive select keys are used to select a single feature from a group. Selecting a key activates the feature and all other exclusive select keys in that group are deselected. The keys are displayed in their selected or default condition. If selection is required, the SEND key is not displayed until a selection is made.

② Nonexclusive Select Key

The square-shaped nonexclusive select keys are used to select multiple features. Selecting a key activates the feature. The keys are displayed in their previously selected or default condition. If selection is required, the SEND key is not displayed until a selection is made.

Information Messages

Messages are displayed in an information box at the bottom of the MFD. The information box covers command keys. Information messages, such as **INVALID ENTRY**, are cleared by selecting **EXIT INFO**. Some information messages automatically disappear.



77710012

① Information Message Text

The text starts at the left of the box.

② EXIT INFO Key

Select - Removes the information box for the displayed message from the display.

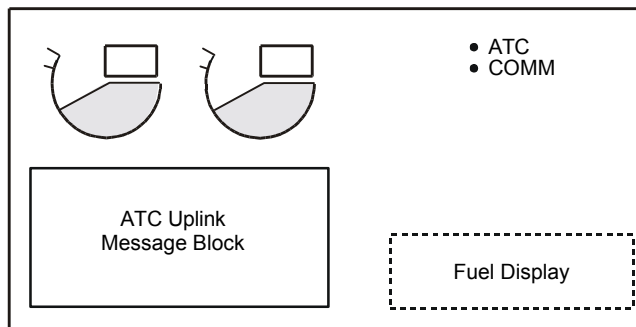
Communications Information Messages

Communications information messages are described in the following table.

Information Message	Condition
ABORTED	ATC connection not established, lost, or loss of handoff to a new active center, while a message is transmitting, or before acceptance.
ACCEPTED	ACCEPT response received.
ACCEPTING	ACCEPT response sent.
DISPLAYED	All pages of a message not requiring an ACCEPT or REJECT response have been displayed.
COMM MASTER TRANSITION – ALL COMPANY MESSAGES LOST	Data link air / ground link switched to a new ground station while company messages are being received or transmitted. All uplinked or downlink incomplete company messages are lost and must be created again and transmitted. ATC uplink and downlink messages are queued and transmitted after connection is again established.
INCOMPLETE MESSAGE	Only part of the displayed message is received.
INVALID ENTRY	An entry box is selected and the CDU scratchpad value is not valid.
LOADING	ATC uplink route modification is loading into the FMC.
MESSAGE TO PRINTER	Selected message(s) sent to printer.
NO ACCEPT (company)	ACCEPT response is not successfully transmitted or an ACCEPT response is not required.
NO PRINT	An attempt to send a message(s) to the printer is unsuccessful.
NO REJECT (company)	REJECT response is not successfully transmitted or a REJECT response is not required by the message.
NO SEND	An attempt to send a downlink message is unsuccessful.
PRINTING	ATC message is printing.

Information Message	Condition
REJECTED	REJECT response received.
REJECTING	REJECT response transmitting.
SENDING	The downlink message is sent.
SENT	The downlink message is received.
UNABLE TO LOAD	ATC uplink route modification can not be loaded into the FMC.

Uplink Message



EICAS

77710013

ATC Uplinks

Arriving ATC uplink messages are annunciated by an ATC communications message, a HI-LO chime, and the display of the EICAS ATC message block. The message text is displayed below the normal EICAS engine display. Uplink messages too large to fit in the message area display the message **LARGE ATC MESSAGE**. The message text is displayed using the NEW MESSAGE menu selection.

Company Uplinks

Arriving company uplink messages are annunciated by a COMM communications message and a HI-LO chime.

Accept, Cancel, Reject Uplinks

ATC messages requiring an accept or reject response display those options in the EICAS display. The message page displays **ACCEPT**, **CANCEL**, **REJECT**, and **REJECT REASONS** keys at the bottom. Select **ACCEPT**, or **REJECT** to respond to the uplink message. Selecting **CANCEL** withdraws a previous **ACCEPT** or **REJECT** downlink message. Select **REJECT REASONS** to inform ATC why the message is rejected.

Company messages can be accepted or rejected on the message page.

After making a selection, the status changes to **ACCEPTING/REJECTING** while the response is transmitting. When ATC or the company receives the response, the message status changes to **ACCEPTED/REJECTED**.

The **ACCEPT**, **CANCEL**, and **REJECT** buttons on the glareshield perform the same function as the same keys on the MFD.

Standby Response

When more time is required to respond to an ATC uplink, use the **STANDBY** key to send a delay notification.

Reject Reasons Page

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES

1234Z REJECT REASONS

☐ DUE TO AIRCRAFT PERFORMANCE

☐ DUE TO WEATHER

☐ NOT CONSISTENT, PLEASE RE-SEND

FREE TEXT:

77710100

If the response to an ATC uplink message is to reject the message, the **REJECT REASONS** key can be selected to inform ATC why the clearance message is being rejected. Up to three lines of text can be included. Select **REJECT** to send the reject message with the applicable reasons.

ATC DATA LINK

ATC data link communicates with participating air traffic control centers, reducing the need for VHF voice communications. Airplane situation reports, route changes, speed and vertical clearances, and voice contact requests can be sent or received as appropriate. The COMM display ATC menu selection allows display of downlink message pages.

Uplink and downlink messages are stored. All messages are assigned the time of receipt / transmission and are printable.

ATC data link requires manual logon to a participating ATC facility. Once logged on, transfer to adjacent ATC facilities is normally automatic.

Crew Feedback

ATC uplinks containing clearance data that the crew can set on the MCP or EFIS control panel have a crew feedback display function. When the message is displayed on EICAS or the message page, the data values change from white to green when properly set by the crew. Data which provides feedback is:

- MCP speed
- MCP heading
- MCP altitude
- Altimeter setting
- Transponder code
- VHF frequency
- HF frequency

FMC Data Loading

Some ATC uplinks contain data for loading into the FMC. Display of the **LOAD FMC** command key indicates that FMC data is available for loading. Selecting **LOAD FMC** transfers data to the FMC and creates an FMC modification.

Both MFD information messages and FMC scratchpad messages provide indications of loading progress.

ATC MENU

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
ATC		
ALTITUDE REQUEST	WHEN CAN WE EXPECT	EMERGENCY REPORT
ROUTE REQUEST	VOICE CONTACT REQUEST	ATC REQUESTED REPORTS... POSITION REPORT
SPEED REQUEST	LOGON / STATUS	
CLEARANCE REQUEST		FREE TEXT MESSAGE

77710014

The ATC menu provides access to ATC downlink pages.

For a complete description of individual pages see Section 3-1, ATC PAGES.

FLIGHT INFORMATION MENU

The flight information function is reserved for future use. The communications main menu **FLIGHT INFORMATION** selection is inhibited.

COMPANY MENU

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
COMPANY		
INITIALIZE	IN-RANGE REPORT	FREE TEXT
ATIS	SOCC POSITION REPORT	SITUATION
WEATHER REQUEST	ENGINE DATA	SENSOR STATUS
TAKEOFF DELAY	ETA UPDATE	PRINTER TEST
RETURN TO FIELD	DIVERSION REPORT	OOOI TIMES
VHF LINK TEST	HOLD	DELAY MESSAGES
REQ OCEANIC CLEARANCE	REQUEST GATE	POST FLIGHT REPORT
LANDING GROSS WEIGHT		
		EXIT

77710064A

The Company main menu may be accessed by selecting the COMPANY function.

- COMPANY in the B777 is used to describe ACARS data communications. The acronym AOC communications where used, refers to Aircraft Operational Control. AOC is Company voice or ACARS data communications as distinguished from ATC or ATS communications.
- ATS is Air Traffic Service. The term is used to describe a service usually provided by an ATC unit. Digital ATIS or PDC would be an example of an ATS function.

Initialize







ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
INITIALIZE		
FLT NO ----	FOB ----_LBS	<div style="border: 1px solid black; padding: 2px; text-align: center;"> ▲ 1 2 ▼ </div>
DATE --	BD FUEL ----_GALS	
DEP ----	GALS	
DES ----	LTRS	
FLT TIME _:_--	DENSITY <u>6.7</u> LBS/GAL	
<input checked="" type="checkbox"/> AUTO		
SEND	RETURN	EXIT

77710065

- The INITIALIZE page is used to initialize the system.
- The AUTO box defaults to checked.
- Selecting the **SEND** prompt sends the request for auto initialization. When selected, **SEND** changes to **SENDING**, followed by **SENT** when the message is acknowledged by the service provider; ARINC, SITA, etc.
- When the ground system responds with the INITIALIZE up link, the crew will observe an EICAS **COMM** message, accompanied by a high-low chime.
- All fields will be completed by the INITIALIZE up link if communications are available, except BD FUEL. This field is completed by crew entry after the fuel slip is received.
- The FLT NO field propagates from ROUTE page 1.
- BD FUEL defaults to Gallons. Liters may be selected by the crew if applicable.
- Selection of page 2 brings up the CALCULATE FUEL ONBOARD page.
- If LTRS is selected, BD FUEL will show LTRS, and DENSITY will show LBS/LTR.

- DENSITY defaults to 6.7 pounds per gallon (1.8 lbs. / ltr), and may be modified by the crew.
- If the system is NO COMM (data Communications lost), the system must be manually initialized by crew entry.






Calculate Fuel On Board

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
CALCULATE FUEL ON BOARD		
FOB nnn.n LBS BOARDED FUEL nnnnn GALS (or LTRS) ARR FUEL nnn.n LBS CALCULATED FOB nnn.n LBS RE-CHECK FUEL ENTRIES ERROR > 2%		  1   2  

77710068

- This page accessed from the INITIALIZE page.
- The system uses the sum of sensed FOB and crew entered BOARDED FUEL.
- This sum is added to the POST FLIGHT REPORT FOB from the previous flight leg and the result is displayed as the CALCULATED FOB.
- The CALCULATED FOB is then compared to the sensed FOB.
- If there is a difference greater than 2 percent between CALCULATED FOB and sensed FOB, the error message RE-CHECK FUEL ENTRIES ERROR >2% is displayed on both the INITIALIZE and CALCULATE FOB pages. Entries can be made or edited on either of these two pages.

ATIS

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
ATIS		
<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;">      </div> <div> DEPARTURE ARRIVAL SINGLE REQUEST --> STA: <input type="text"/> AUTO UPDATE --> STA: <input type="text"/> TERMINATE AUTO --> STA: <input type="text"/> UPDATE </div> </div>		
SEND	RETURN	EXIT

77710066

- STA requires a four character ICAO station identifier.
- The page will default to DEP during gate and taxi out operations.
- The page will default to ARR if the aircraft is in flight or on the ground taxiing in. Default changes to DEP at block IN.
- The AUTOMATIC UPDATE feature, when selected, will automatically send a new ATIS message when available. Only one station may be selected for automatic updates.
- If automatic updates are desired from another station, automatic updates must be terminated from the previous station.
- TERMINATE AUTOMATIC UPDATES will suspend the automatic updates for the selected station.
- The **SEND** prompt must be selected to generate the request for ATIS.

Note: The AUTO UPDATE feature may not be available at most airports. It is a function of the Service Provider generating the report; i.e.: ARINC, SITA, ETC.

Weather Request

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
WEATHER REQUEST		
<input checked="" type="checkbox"/> ACTUAL	STA <u>K E W R</u>	
	STA _ _ _ _	
<input type="checkbox"/> FORECAST	STA _ _ _ _	
<input type="checkbox"/> SIGMET [STATION]		
<input type="checkbox"/> PIREPS		
<input checked="" type="checkbox"/> CONVECTIVE SIGMET [U.S. ONLY]	<input checked="" type="checkbox"/> EAST	
	<input type="checkbox"/> CENT	
	<input type="checkbox"/> WEST	
SEND	RETURN	EXIT

77710069

- Entered stations can be three or four character identifiers.
- SIGMENTS are station reports for icing, severe turbulence or volcanic ash.
- CONVECTIVE SIGMENTS are U.S. reports separated into three regions defined by 87 degrees and 107 degrees west longitude. The three regions, EAST, CENT and WEST are only displayed when the CONVECTIVE SIGMENTS box is checked.
- The ACTUAL weather STA defaults to the departure station if the flight is at the gate or taxiing out but not OFF; and to the destination station if the flight is airborne or has landed but not reached the gate.
- CONVECTIVE SIGMENTS are routed directly to the printer due to their length.

Takeoff Delay

ATC	FLIGHT INFORMATION	COMPANY						
REVIEW	MANAGER	NEW MESSAGES						
TAKEOFF DELAY								
<p>Estimated delay from now to OFF time in minutes: <input type="text"/> <input type="text"/> <input type="text"/></p> <table> <tr> <td> ATC</td> <td> HOLD FOR LOADING</td> </tr> <tr> <td> ARPT TFC</td> <td> WEATHER</td> </tr> <tr> <td> WT / BALANCE</td> <td> MAINTENANCE</td> </tr> </table> <p>OTHER: _____ _____ _____</p>			ATC	HOLD FOR LOADING	ARPT TFC	WEATHER	WT / BALANCE	MAINTENANCE
ATC	HOLD FOR LOADING							
ARPT TFC	WEATHER							
WT / BALANCE	MAINTENANCE							
SEND	RETURN	EXIT						

77710070

- This report is used to inform the dispatcher the crew's estimate of the estimated take off time.
- Selectable reasons for delays are chosen using the CCD, and three lines are available for free text following OTHER.
- This estimated take off time is added to the flight plan ETE, and then to the scheduled arrival taxi time to compute the ETA.

Return To Field

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
RETURN TO FIELD		
DESTINATION _ _ _ _		
REMARKS: _____ _____ _____ _____		
SEND	RETURN	EXIT

77710071

- Departure station is default field.
- When **SENT**, also transmits a gate assignment request.
- Four lines of free text is available following REMARKS:.

VHF Link Test

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
VHF LINK TEST		
DESTINATION : OK NO COMM		
PRESS SEND TO TEST TEST COMPLETE WHEN SENT APPEARS BELOW		
SEND	RETURN	EXIT

77710072

- This page is used to verify that the VHF connection is available and working.
- After the **SEND** prompt is selected the message is transmitted.
- When **SENT** appears in the box, it indicates the service provider has acknowledged the down link message with an up linked response. This indicates the system is communicating properly. It does not indicate any problems with missing, incomplete or incorrect messages.

Note: If an incorrect or partial message is received and **DATA LINK FAIL** is not annunciated on EICAS, and the LINK TEST is valid, a problem outside Flight Deck Comm (ACARS) is usually indicated. This problem may reside in Service Provider message processing, airline host computer processing (FOMS), or rejection of the up linked message by the peripheral addressee, i.e., the FMC or printer.

Req Oceanic Clearance

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z NORTH ATLANTIC OCEANIC CLEARANCE REQUEST XXXXXXXXX		
① → ICAO FLT NBR: COA <input type="text"/>	FACILITY: <input type="text"/>	
② → ENTRY POINT: <input type="text"/>	◆ SHANWICK	
③ → ENTRY PT ETA: <input type="text"/> : <input type="text"/> Z		
④ → FLIGHT LEVEL: <input type="text"/>		
⑤ → MACH: <input type="text"/>		
⑥ → REMARKS: MAX FLT LEVEL: <input type="text"/>	ALT TRACK: <input type="text"/>	⑦ ←
⑧ → OTHER: <input type="text"/>		
SEND	RESET	RETURN EXIT

7776056

- ① ICAO FLT NBR COA
Enter actual flight number as filed. No leading zeros.
- ② ENTRY POINT
Enter the Shanwick Oceanic boundary point LAT/LONG in the format: **N55W010** or **55N010W**. Do not use the abbreviated format or the request will be rejected; i.e. 5510N.
- ③ ENTRY PT ETA
Enter the ETA for the Track Entry Point.
- ④ FLIGHT LEVEL
Enter the requested Flight Level.
- ⑤ MACH
Enter the requested MACH number using the decimal even though the decimal already appears.
- ⑥ REMARKS MAX FLIGHT LEVEL
Enter the maximum acceptable Flight Level at the entry point.
- ⑦ ALT TRACK
Enter the Optional Track listed on the Flight Plan or other alternate track as desired.
- ⑧ OTHER
Enter any remarks you wish to convey to the controller.

Landing Gross Weight

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
COMPANY		
<p align="center">LANDING GROSS WEIGHT CREW ADVISORY</p> <p align="center">BASED ON CURRENT CONDITIONS LANDING GROSS WEIGHT IS EXPECTED TO BE nnn.n POUNDS.</p> <p>ZFW: --- • ---</p> <p>FUEL AT DEST: --- • ---</p> <p>LANDING GW: --- • ---</p> <p align="center">PREDICTED LANDING GROSS WEIGHT EXCEEDS MAXIMUM STRUCTURAL WEIGHT OF 460.0 KLBS</p>		
RESET	PRINT	RETURN

77710101

- Continuously calculates and displays FUEL AT DEST and LANDING GW.
- Has automatic pop-up feature at 3, 2, and 1 hour prior to FMC computed ETA.
 - Pop-up activated if predicted landing gross weight is estimated to be equal to or greater than 458 KLBS.
 - A •COMM is annunciated on EICAS with a high / low chime.
 - Selecting the COMM function on the DSP displays the LANDING GROSS WEIGHT ADVISORY page with ZFW, FUEL AT DEST, LANDING GW, and the statement:
 BASED ON CURRENT CONDITIONS PREDICTED LANDING GROSS WEIGHT IS EXPECTED TO BE XXX.X POUNDS.
 If structural landing gross weight is predicted to be exceeded the following statement is also displayed:
 PREDICTED LANDING GROSS WEIGHT EXCEEDS
 MAXIMUM STRUCTURAL WEIGHT OF 460.0 KLBS.
- If a diversion is executed, the 3, 2, and 1 hour weight check is made based on the new destination ETA. If the ETA is less than 1 hour away, and the above conditions are met, the pop-up occurs five minutes after the diversion is executed.
- The FUEL AT DEST and LANDING GW values may be viewed anytime during the flight by selecting COMM on the DSP, COMPANY main menu, and the LANDING GROSS WEIGHT page.

In Range Report

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
IN RANGE REPORT		
ETA AT GATE _ _ _ _ Z WHEELCHAIRS _ _ ELEC CART _ _ UNAC MINORS _ _		<input checked="" type="checkbox"/> RED COAT <input checked="" type="checkbox"/> GND POWER <input checked="" type="checkbox"/> LAV SERVICE <input type="checkbox"/> AIR COND
OTHER: _____ _____ _____ _____		
SEND	RETURN	EXIT

77710073

- Selecting **SEND** will down link this message via VHF communications only. If VHF is not available, the message will be queued until VHF is available.
- The ETA AT GATE requires crew entry. There is no default value.
- RED COAT, GND POWER and LAV SERVICE requests default to enabled. AIR COND defaults to not enabled. WHEELCHAIR, ELEC CART and UNAC MINORS use one or two numeric entries. If none, leave blank.
- Four lines of free text are available following OTHER.

Note: This page will be called up automatically, if a selected MFD is in the COMM mode, when time remaining to destination is <60 minutes and altitude is equal to or >10,000 feet.

SOCC Position Report

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
SOCC POSITION REPORT		
POS: _____ ATA: _____ ALT: _____ ETA: _____ EST: _____ POS FUEL: _____ NEXT: _____ SAT: -__C WIND DIR / SPD: ____ / ____		<div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; position: relative;"> ▲ ▼ </div> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; position: relative;"> 1 2 </div>
<div style="border: 1px solid black; padding: 2px; display: inline-block;">SKY COND</div>	<div style="border: 1px solid black; padding: 2px; display: inline-block;">TURB *</div>	<div style="border: 1px solid black; padding: 2px; display: inline-block;">ICING *</div>
<div style="border: 1px solid black; padding: 2px; display: inline-block;">CLR</div> <div style="border: 1px solid black; padding: 2px; display: inline-block;">IN CLDS</div> <div style="border: 1px solid black; padding: 2px; display: inline-block;">BTWN LVR</div> <div style="border: 1px solid black; padding: 2px; display: inline-block;">ON TOP</div>	<div style="border: 1px solid black; padding: 2px; display: inline-block;">NONE</div> <div style="border: 1px solid black; padding: 2px; display: inline-block;">LITE</div> <div style="border: 1px solid black; padding: 2px; display: inline-block;">MOD</div> <div style="border: 1px solid black; padding: 2px; display: inline-block;">SVR</div>	<div style="border: 1px solid black; padding: 2px; display: inline-block;">NONE</div> <div style="border: 1px solid black; padding: 2px; display: inline-block;">LITE</div> <div style="border: 1px solid black; padding: 2px; display: inline-block;">MOD</div> <div style="border: 1px solid black; padding: 2px; display: inline-block;">HVY</div>
<div style="border: 1px solid black; padding: 2px; display: inline-block;">SEND</div>	<div style="border: 1px solid black; padding: 2px; display: inline-block;">RESET</div>	<div style="border: 1px solid black; padding: 2px; display: inline-block;">RETURN</div>
<div style="border: 1px solid black; padding: 2px; display: inline-block;">EXIT</div>		

77710074

- The SEND prompt will display when all mandatory fields are entered. When the report is completed, selecting the SEND prompt will transmit the report to the dispatcher in SOCC.
 - Mandatory fields are POS, ATA, ALT, EST, ETA, NEXT and POS FUEL. All other fields are optional.
 - Selection boxes for SKY COND, TURB and ICING are pull down type menus; the selections will appear when the title word is selected. Eight characters of free text can be entered under SKY COND. Four characters of free text can be entered under TURB and ICING.
 - The POS, EST and NEXT positions allow up to 15 characters, permitting entry of named intersections as well as Latitude / Longitude.
- * Note: TURB and ICING prompts are displayed on page 2.

Engine Data Report

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
ENGINE DATA REPORT		
GR WEIGHT: nnn.n ALTITUDE: nnnnn IAS: nnn MACH : .nnn TAS: nn		TAT: -nn SAT: -nn
<input checked="" type="checkbox"/> PACK ON – L ON <input checked="" type="checkbox"/> PACK – R ON		<div style="text-align: center;">▲</div> <div style="text-align: center;">1</div> <div style="text-align: center;">2</div> <div style="text-align: center;">▼</div>
<input checked="" type="checkbox"/> ISO - L CLSD <input checked="" type="checkbox"/> ISO - C CLSD <input checked="" type="checkbox"/> ISO - R CLSD		
SEND	PRINT	RETURN
EXIT		

77710075a

- The ENGINE DATA REPORT is used to send an ACARS manual engine data snapshot to maintenance due to a failure of the normal Aircraft Condition Monitoring System (ACMF). ACMF is a high speed data system that performs a wide range of monitoring and reporting.
- Page 1 of the report is basic flight and pneumatic conditions. Most fields are manual entry or overwrite. Some fields may default to actual current values where they can be read by the system.
- Page 2 of the report is the engine indications which are read from EICAS and manually entered by the crew.

Engine Data Report

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
ENGINE DATA REPORT		
<div>LEFT N1: nnn.n EGT: nnn N2: nnn.n FF: nnnn OILP: nnn OILT: nnn OILQ: nnn VIB: n.n — N1 — N2 — BB [x] BLEED ON</div>		<div>RIGHT N1: nnn.n EGT: nnn N2: nnn.n FF: nnnn OILP: nnn OILT: nnn OILQ: nnn VIB: n.n — N1 — N2 — BB [x] BLEED ON</div>
		<div>▲</div>
		<div>1</div>
		<div>2</div>
		<div>▼</div>
SEND	PRINT	RETURN EXIT

77710076

- All fields are manual crew entry only. Select the **SEND** prompt when ready to transmit the report.

ETA Update

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
ETA UPDATE		
DESTINATION <u>K E W R</u>		▲
ETA AT GATE ----- Z		1
OPTIONAL REASONS / REMARKS ON PAGE 2		2
		▼
SEND	PRINT	EXIT

77710077

- The report is inhibited on the ground.
- The report is enabled one hour after takeoff and aircraft altitude is at least 27,000 feet.
- When enabled, a snap shot of the FMC ETA is taken and saved as a reference ETA.
- Any change in the FMC ETA > 10 minutes and stabilized for 10 minutes, will cause this page to pop up (if the MFD is in COMPANY mode), accompanied by a chime and EICAS message. At that time, another snap shot of the new ETA will be taken and become the new reference.
- If not in the COMPANY menu when a change in ETA occurs, a chime will sound and a COMM message will appear on EICAS. When the COMM button is pressed on the DSP, the ETA UPDATE page will be first to display.

Note: A crew ETA update will override any other ETA in the Airline system, including the destination terminal display screens.

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
ETA UPDATE		
REASONS		<div>▲</div> <div>1</div> <div>2</div> <div>▼</div>
<input type="checkbox"/> DEPARTURE ATC	<input type="checkbox"/> WINDS	
<input type="checkbox"/> ENROUTE ATC	<input type="checkbox"/> WEATHER	
<input type="checkbox"/> MECHANICAL	<input type="checkbox"/> HOLDING	
REMARKS: _____ _____ _____		
SEND	RETURN	EXIT

77710078

- This page is optional. The reasons can be checked as desired, and up to four lines of free text can be entered. The **SEND** prompt is displayed on both pages of the ETA UPDATE.

Diversion Report

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
DIVERSION REPORT		
DIVERSION STA _ _ _ _ ETA AT GATE _ _ _ _ Z FOB _ _ _ _ REASONS <input type="checkbox"/> DEP ATC <input type="checkbox"/> WINDS <input type="checkbox"/> ENR ATC <input type="checkbox"/> WEATHER <input type="checkbox"/> MECH <input type="checkbox"/> HOLDING REMARKS: _____ _____ _____		
SEND	RETURN	EXIT

77710079

- This report is inhibited on the ground.
- The DIVERSION REPORT is used to inform SOCC of a divert decision.
- When the FMC destination is changed, the new destination will propagate to this page.
- This page will pop up automatically if in the COMPANY menu. If not, a high-low chime will sound and a **COMM** EICAS message will be displayed. When the COMM button is pressed on the DSP, this page will be first to display.
- The STA, ETA and FOB are mandatory fields and must be entered for the **SEND** prompt to display.
- REASONS are optional and may be checked as desired.
- Three lines of free text are available to include with the message.

Note: The ETA AT GATE is SOCC Dispatcher advisory only and will not update the system ETA since the destination airport has now changed.

Holding Report

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
HOLDING REPORT		
<div><div>◆ ENTER HOLD</div><div>◇ LEAVE HOLD</div></div> <div>FIX _____ FOB _____</div> <div>REMARKS: _____ _____ _____ _____</div>		
SEND	RETURN	EXIT

77710080

- FIX and FOB are mandatory entries in order to display the **SEND** prompt.
- FIX can be a named intersection or a 15 character alpha-numeric Latitude / Longitude.
- Four lines of free text may be entered after REMARKS if desired.
- FOB will propagate from totalizer but may be modified by crew entry.

Request Gate

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
REQUEST GATE		
ETA AT GATE ____ Z		
SEND	RETURN	

77710081

- Selecting the **SEND** prompt will down link a request for a gate assignment up link.
- ETA is an optional entry.

Note: This ETA will not update FOMS. It is Station Operations agent information only.

Free Text

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
FREE TEXT		
◇ DISPATCH	◇ DATA LINK OP PROBLEM	◇ NAV DATA OP PROBLEM
		◆ MX MESSAGE
_____ _____ _____ _____ _____ _____ _____		1 _____ 2 _____ _____
		FRM CODE _____
		THIS MESSAGE WILL BE SENT TO MAINTENANCE CONTROL AND DISPATCH
SEND	RETURN	EXIT

77710082

- The FREE TEXT message page is used to communicate with Dispatch, Maintenance Control, or to describe a **DATA LINK** or **NAV DATA OPERATIONAL** problem.
 - If the **MX MESSAGE** diamond is selected, the FRM CODE box is displayed, and an optional 10 character alpha-numeric code may be entered.
 - The **DATA LINK OP PROBLEM** prompt is selected to enter text describing a data link problem. The report will arrive in Maintenance Control and be forwarded to a database for review by company ACARS operations or flight technical employees.
 - The **NAV DATA OP PROBLEM** prompt is selected to enter text describing a problem with navigation data (i.e., a NAV database or FMC problem). The report will arrive in Maintenance Control and be forwarded to a database for review by ACARS operations or flight technical employees.
 - Text is entered on the CDU keypad and appears in the CDU scratchpad, and then selected to the appropriate line on this page using the cursor control device.
 - There are 8 text lines on page 1, and 9 lines on page 2. Each line on the MFD can accept only 24 characters due to CDU scratch pad constraints.
- Note: A DATA LINK OP PROBLEM or NAV DATA OP PROBLEM report should be followed up by a Log Book write up upon arrival. The DLOP or NDOP report is intended to allow information transfer while event recall is still fresh.

- A statement as to where the selected message will be addressed appears to the right of the text lines.

Situation Report

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
SITUATION REPORT		
◆ 7500	◇ 7700	△
REMARKS: _____		1

_____		2

_____		▽
SEND	RETURN	RESET
EXIT		

77710084

- 7500 or 7700 must be selected to display the **SEND** prompt.
- Entry of free text is not mandatory.
- Reset will blank 7500 or 7700 selection.
- Page 2 is covert 7500 report.

ATC	FLIGHT INFORMATION	COMPANY	
REVIEW	MANAGER	NEW MESSAGES	
SITUATION REPORT			
7500			
ELAM <u> </u>	MEF <u> </u>	<div style="border: 1px solid black; padding: 2px;"> <div style="text-align: center;">▲</div> <div style="text-align: center;">1</div> <div style="text-align: center;">2</div> <div style="text-align: center;">▼</div> </div>	
PAEW <input type="checkbox"/> YES <input type="checkbox"/> NO	TPCNI <input type="checkbox"/> YES <input type="checkbox"/> NO		
PMET <input type="checkbox"/> NWONKU <input type="checkbox"/> MLAC <input type="checkbox"/> ESNENI			
SEND	RETURN	RESET	EXIT

77710085

Selecting RESET will de-select choices.

- ELAM is male; number?
- MEF is female; number?
- PAEW is weapon; Y or N.
- TPCNI is in cockpit; Y or N.
- PMET is temperament; unknown; calm; intense.

Sensor Status

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
SENSOR STATUS		
<p>AIRLINE ID: CO REGISTRATION NUMBER: N78001 0001 STATE: OUT/OFF/ON/IN ENGINES: OFF ON GND / AIR: GND AIR PARKING BRAKE: SET RELEASED DOORS: OPEN CLOSED FLIGHT PHASE: nn</p>		
RETURN		EXIT

77710086

- This page will contain the position of various sensors aboard the aircraft.
- The position or state of these sensors is required for Flight Deck Comm to employ various triggers to generate, display or send reports. An example would be; all doors closed, parking brake released, generates an OUT time in the system.
- The page is for maintenance troubleshooting and has no practical usefulness for flight crews.

Printer Test

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
PRINTER TEST		
PRESS PRINT TO TEST		
<div>PRINT</div> <div>RETURN</div> <div>EXIT</div>		

77710087

- When the **PRINT** prompt is selected the following message will be sent to the printer.

<p>PRINTER TEST MESSAGE</p> <p>THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG'S BACK.</p> <p>END TEST</p>

- No **SEND** prompt is displayed.

000I Times

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
<p align="center">000I TIMES CURRENT FLIGHT</p>		
FLT NO _ _ _ _	DEP / DES _ _ _ _ / _ _ _ _	▲
OUT _ _ _ _	OFF _ _ _ _	1
IN _ _ _ _	ON _ _ _ _	
BLOCK TIME _ _ : _ _	FLIGHT TIME _ _ : _ _	2
		▼
PRINT	RETURN	EXIT

77710088

- The OUT, OFF, ON, IN or 000I TIMES page is available for display after the POST FLIGHT REPORT is sent.
- Page 2 contains the relevant times for the flight leg just completed. (See illustration next page.)

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
OOOI TIMES PREVIOUS FLIGHT		
FLT NO __35	DEP / DES EGKK/KIAH	<div>▲</div> <div>1</div> <div></div> <div>2</div> <div>▼</div>
OUT 1040	OFF 1102	
IN 2121	ON 2115	
BLOCK TIME 10:41	FLIGHT TIME 10:13	
PRINT	RETURN	EXIT

77710089

- The CURRENT FLIGHT OOOI times will revert to PREVIOUS FLIGHT after the POST FLIGHT REPORT is sent.
- Both pages are printable.

Delay Messages

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
COMPANY		
INITIALIZE	IN-RANGE REPORT	FREE TEXT
ATIS	SOCC POSITION REPORT	SITUATION
WEATHER REQUEST	ENGINE DATA	SENSOR STATUS
TAKEOFF DELAY	ETA UPDATE	PRINTER TEST
RETURN TO FIELD	DIVERSION REPORT	OOOI TIMES
VHF LINK TEST	HOLD	DELAY MESSAGES
	REQUEST GATE	POST FLIGHT REPORT

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
DELAY MESSAGES		
◀ OUT TO OFF	◇ OFF TO ON	◇ ON TO IN
MINUTES <input type="text"/>	MINUTES <input type="text"/>	MINUTES <input type="text"/>
◇ LOADING BAGGAGE		
◇ RAMP CONGENSTON		
◇ ATC/GROUND CONTROL DELAYS		
◇ AIRCRAFT DEICING		
◇ NO PUSHBACK CREW		

77710098

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
DELAY MESSAGES		
◇ OUT TO OFF	▶ OFF TO ON	◇ ON TO IN
MINUTES <input type="text"/>	MINUTES <input type="text"/>	MINUTES <input type="text"/>
◇ REROUTE DUE TO WEATHER/ATC		
◇ HEADWINDS > FORECAST		
◇ REDUCED SPEED / VECTORIZING / HOLDING DUE TO ATC		

77710098A

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
DELAY MESSAGES		
◇ OUT TO OFF	◇ OFF TO ON	◆ ON TO IN
MINUTES	<input type="text"/>	MINUTES
<input type="text"/>	MINUTES	<input type="text"/>
◇ NO GATE AGENT / JETWAY DRIVER		
◇ RAMP EQUIPMENT IN SAFETY ZONE		
◇ NO MARSHALLER / WING WALKERS		
◇ ATC / GROUND CONTROL DELAYS		
◇ RAMP CONGESTION		
◇ GATE OCCUPIED		

77710098B

These pages may be accessed during any flight phase.

- There is no SEND prompt, the selections are automatically transmitted as a separate message after the POST FLIGHT REPORT is SENT.
- These delay messages are functional as soon as installed in the aircraft.
- Please communicate these messages to assist in isolating delay events.

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REVIEW STATE INDICATORS

Each review message list field and each review message displays the last state of the referenced message. Only one state can apply to a message at a time.

State Indicator	Condition
ABORTED	ATC data link connection lost before sending response to uplink message or completing a downlink message.
ACCEPTING	The received message was displayed and an ACCEPT response was initiated.
ACCEPTED	The received message was displayed, an ACCEPT response was initiated, and the service provider has acknowledged receipt of the response.
DISPLAYED	The received message was displayed (no accept / reject response was required).
NO ACCEPT	The received message was displayed, an ACCEPT response was initiated, but the service provider did not acknowledge receipt of the response.
NO REJECT	The received message was displayed, a REJECT response was initiated, but the message destination did not acknowledge receipt of the response.
NO SEND	The downlink message was initiated to be sent and the service provider did not acknowledge receipt of the message.
REJECTING	The received message was displayed and a REJECT response was initiated.
REJECTED	The received message was displayed, a REJECT response was initiated, and the message destination has acknowledged receipt of the response.
RESPONSE RECEIVED	ATC uplink message received in response to a downlink request.
SENDING	The downlink message was initiated to be sent.
SENT	The downlink message was initiated to be sent and the service provider has acknowledged receipt of the message.

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MANAGER FUNCTIONS**Manager Menu**









ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
MANAGER		
ACARS	SYSTEM INFO	
VHF	PRINTER	
SATCOM	AUTOMATIC MESSAGES	
ADS	MASTER	

Typical MANAGER Menu

77710034

The MANAGER menu page provides access to the manager functions.

ACARS Manager

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z	ACARS	
 131.550 126 SEC		
 131.725 126 SEC		1
 131.475 126 SEC		
 136.925 126 SEC		2
 SECONDARY FREQUENCY	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	

77710035




The ACARS MANAGER page provides selection of ACARS frequencies, scan rates, and mode. Manager messages related to ACARS are on ACARS page two.

If a FREQUENCY key is selected, the ACARS system tunes to the appropriate frequency and scan rate. If a secondary frequency is entered, the SECONDARY FREQUENCY key becomes active and must be selected to tune to the secondary frequency. Frequency and scan rate selections can be changed automatically by ACARS.





Note: 126 seconds represents the time the system remains on that frequency listening for data traffic before moving on to the next frequency in the table. This is called the scan rate.

ACARS Manager Page 2/2

ACARS MODE AUTO is the normal ACARS mode. This permits the ACARS system to automatically select the VHF or SATCOM (if VHF is unavailable) mode. If **ACARS MODE VHF** is selected, ACARS changes to VHF. If **ACARS MODE SATCOM** is selected, ACARS changes to SATCOM.

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z ACARS		
 ACARS MODE AUTO	 ACARS MODE VHF	 ACARS MODE SATCOM
(ACARS Manager Messages)		

VHF Manager

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  DEFAULT RADIO CENTER </div> <div style="text-align: center;">  DEFAULT RADIO RIGHT </div> </div> <div style="text-align: center; margin-top: 10px;">  DEFAULT RADIO MODE: DATA </div> <div style="text-align: center; margin-top: 10px;">  DEFAULT RADIO MODE: VOICE </div> <p style="text-align: center;">(VHF Manager Messages)</p>		

77710037

Changes to the default radio selections are inhibited (cyan text) unless the ACARS mode VHF is selected on page 2 of the ACARS manager pages. If the DEFAULT RADIO CENTER key is selected, the center VHF radio becomes the default radio. If the DEFAULT RADIO RIGHT key is selected, the right VHF radio becomes the default radio.

The VHF manager page provides the capability to select the default radio and to configure the default radio to the voice or data mode. Manager messages related to the VHF system are also presented on this page.

If the DEFAULT RADIO MODE DATA key is selected, the default radio is set to the data mode. If the DEFAULT RADIO MODE VOICE key is selected, the default radio is set to the voice mode

Note: The default radio can also be set to the data or voice mode via the Radio Tuning Panel.

SATCOM Manager

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z SATCOM		
(SATCOM Manager Messages)		
2209Z SATCOM DATA MODE NORMAL		
2208Z SATCOM LINK ESTABLISHED		
		RETURN
		EXIT

77710038

The SATCOM MANAGER page displays manager messages related to the SATCOM system.

System Information Manager

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z		
SYSTEM INFO		
TAIL NUMBER: N78005		AIRLINE: CO
(All Manager Messages)		
		RETURN EXIT

77710038A

The SYSTEM INFORMATION MANAGER page displays manager messages for all applicable systems.

Printer Manager

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z		
PRINTER		
<input type="checkbox"/> COMPANY MESSAGES FUTURE		
(Display of Printer Manager Messages)		

77710041A

The PRINTER MANAGER page can be set to send messages directly to the printer. Manager messages related to the printer system are also presented on this page.

If the COMPANY MESSAGES FUTURE key is selected, company messages are sent directly to the printer and the **•PRINTER** EICAS message is displayed. Future messages are not included in the new messages or review categories.

Automatic Messages Manager

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z AUTOMATIC MESSAGES		
<div><input checked="" type="checkbox"/> AUTO MESSAGES OFF</div> <div><input type="checkbox"/> CONFIRM OFF</div>		
(Automatic Messages Manager Messages)		

77710041

The **AUTO MESSAGES OFF** selection inhibits automatic sending of flight operations related messages. Manager messages related to the automatic messages capability are also presented on this page.

When the **AUTOMATIC MESSAGES OFF** key is selected, the **CONFIRM OFF** key is displayed. Selecting the **CONFIRM OFF** key turns off the capability to automatically send flight operations related messages.

Master Manager

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z MASTER		
<input checked="" type="checkbox"/> DATA LINK SYSTEM RESET <input type="checkbox"/> CONFIRM RESET		
(Master Manager Messages)		

77710042

The master manager page provides the capability to reset the data communication system. Manager messages related to the master features are also presented on this page.

If the DATA LINK SYSTEM RESET key is selected, the CONFIRM RESET key is displayed. If the CONFIRM RESET key is selected, the following occurs:





- ATC connection is reset to **NOT ESTABLISHED**,
- Review messages are deleted,
- The center VHF radio is selected as the default,
- The VHF default radio set to the DATA mode on the ground; in the air, the default radio is set to **VOICE**,
- ACARS is set to the AUTO mode,
- Automatic messages are set to ON,
- The future company messages to printer feature is deselected,
- Downlink message parameters are initialized,
- Two seconds after selection, the CONFIRM RESET key is removed from the display and the DATA LINK SYSTEM RESET key is displayed as not selected.

This reset does not occur at power-up.

The data communication system is automatically reset after each flight. Reset occurs approximately 9 minutes after the last engine is shut down, and with any passenger entry door open.

Data link capability for the flight management system, FMS, and EICAS related maintenance functions, and cabin functions are not reset with this feature.

Automatic Dependent Surveillance

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z ADS		
<div><div> ADS ARM</div><div> ADS OFF</div></div> <div><div> ADS EMERGENCY</div><div> ADS EMERGENCY OFF</div></div>		
1225Z ADS CONNECTION NOT ESTABLISHED -OAKXGXA 1120Z ADS CONNECTION ESTABLISHED -OAKXGXA 1020Z ADS CONNECTION ESTABLISHED -SEAXGXA		

77710043

When Automatic Dependent Surveillance (ADS) is armed, AUTOMATIC position report messages are sent to ATC and Company.

The ADS page controls the following airplane ADS functions:

- ADS ARM - Allows airplane ADS functions
- ADS OFF - Inhibits airplane ADS functions
- ADS EMERGENCY - Provides more frequent position reports.

A list of ADS connection status is displayed on the ADS page.

MANAGER MESSAGES

Manager messages are displayed in reverse chronological order (the newest message is nearest the top of the display). The time of occurrence is displayed with each message. The manager messages are listed in the following table.

Function	Manager Message
ACARS	ACARS CONNECTION ESTABLISHED
	NO ACARS CONNECTION
	ACARS AUTO MODE
	ACARS VHF MODE
	ACARS SATCOM MODE
ADS	ADS CONNECTION ESTABLISHED ATC FACILITY
	ADS CONNECTION LOST ATC FACILITY
	ADS CONNECTIONS LOST
VHF	VHF LINK ESTABLISHED
	NO VHF LINK
	VHF DATA MODE RADIO FAILURE
	VHF DATA MODE RADIO NORMAL
SATCOM	SATCOM LINK ESTABLISHED
	NO SATCOM LINK
	SATCOM DATA MODE FAILED
	SATCOM DATA MODE NORMAL
PRINTER	PRINTER OPERABLE
	PRINTER NOT OPERABLE
	PRINTER BUFFER FULL
	COMPANY FUTURE MESSAGES TO PRINTER ON
	COMPANY FUTURE MESSAGES TO PRINTER OFF

Function	Manager Message
AUTOMATIC MESSAGES	AUTOMATIC MESSAGES ON
	AUTOMATIC MESSAGES OFF
MASTER	DATA LINK SYSTEM RESET

NEW MESSAGES**New Messages Menu**

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1234Z	NEW MESSAGES	
1228Z	CLIMB AND MAINTAIN FL330	ATC
1233Z	PASSENGER INFORMATION - CONNECTING FLIGHTS	
1220Z	WEATHER INFORMATION FOR KPDx, KSFO, KLAX	
1215Z	CONTACT DISPATCH	

Typical NEW MESSAGE List

77710044

New uplink messages are displayed with ATC messages displayed above company messages. Within ATC and company, messages are listed by the time they are received. The newest message is at the top of the group. Messages are removed from the list when displayed or an accept / reject response is sent.

New messages can also be accessed by selecting the **NEW MESSAGES** menu, which displays list boxes for all pending messages. A message is displayed by selecting the appropriate message line.

New ATC uplinks which respond to downlink requests display a key which displays the original downlink request.

New Message - No Response Required

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1233Z	GATE INFORMATION	
Flight: XX127 Gate: B1 ETA: 1245Z		
PRINT		CANCEL

77710045

Received messages remain in the new messages list until after they are displayed. If an ACCEPT or REJECT response is required, the message remains in the list until accepted or rejected.

The display above shows a received message that does not require a response. The ACCEPT and REJECT keys are not displayed for this message. The message can be cleared by selecting the CANCEL key on the MFD or pushing the CANCEL switch on the glareshield.

New Message - Response Required

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
1233Z GATE INFORMATION		
Flight: XX127 Gate: B1 ETA: 1245Z		
ACCEPT	PRINT	APPEND REJECT

77710046

The display above shows a message that requires an ACCEPT or REJECT response. The ACCEPT and REJECT keys are displayed.

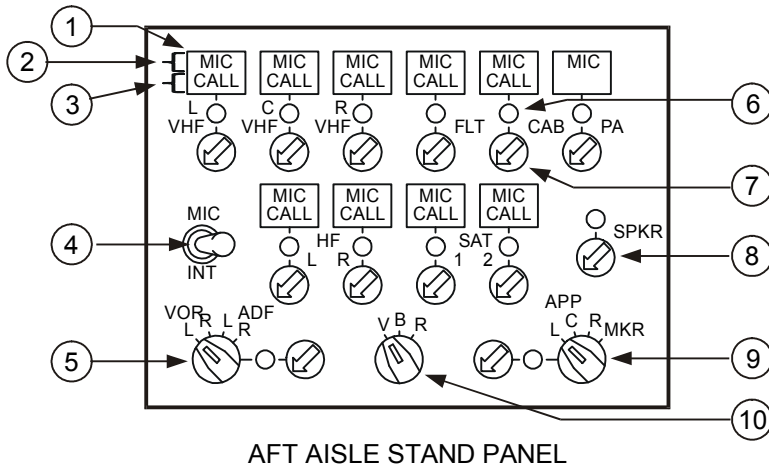
An APPEND capability is provided for certain received messages which require an ACCEPT or REJECT response. In this case, the APPEND key is displayed.

ACCEPT and REJECT prompts can be selected from this screen using the CCD, or directly using the ACCEPT and REJECT buttons located on each pilot's glareshield panel.

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CONTROLS AND INDICATORS

AUDIO CONTROL PANEL (ACP)



77710047

① Transmitter Select Switches

Push -

- The **MIC** light illuminates
- The **MIC** light for any other transmitter extinguishes
- Selects the respective transmitter (radio or intercommunications) for transmission from this crew station (only one can be selected at a time for each crew station)
- Selects the receiver audio on, if not already manually selected on
- Pushing the **CAB** transmitter select switch twice within one second places a priority call to Door 1 Left.

Second push -

- Deselects the transmitter
- Deselects receiver audio.

② **MIC** Lights

Illuminated - Indicates the transmitter is selected.

③ CALL Lights

Illuminated -

- Indicates a call on SELCAL, the flight interphone (FLT), or the cabin interphone (CAB)
- Indicates a call on SELCAL, the flight interphone (FLT), the cabin interphone (CAB), or SATCOM (SAT)
- Resets when the respective transmitter select switch is pushed or, if already pushed, by pressing a MIC/INTERPHONE switch
- Resets when the respective transmitter select switch is pushed or, if already pushed, by pressing a MIC/INTERPHONE switch (the **SATCOM CALL** light remains illuminated until the call ends)
- PA does not have a **CALL** light.

④ MIC/INTERPHONE Switch

MIC - Keys the boom microphone or oxygen mask on the selected radio transmitter or other system.

Center - Off position (spring-loaded to center).

INT - Keys the boom microphone or oxygen mask on the flight interphone.

⑤ VOR/ADF Receiver Selector

Selects the VOR or ADF receiver to be monitored:

- VOR L - Left VOR
- VOR R - Right VOR
- ADF L - Left ADF
- ADF R - Right ADF.

⑥ Receiver Lights

Illuminated - Indicates the respective receiver volume control is manually selected on.

⑦ Receiver Volume Controls

Push - Turns the respective receiver audio on or off.

Rotate - Controls receiver volume.

⑧ Speaker (SPKR) Volume Control

Push - Turns the respective flight deck speaker on or off.

Rotate - Controls flight deck speaker volume.

Note: Inoperative on first observer audio control panel.

Note: Inoperative on first and second observer audio control panels.

⑨ Approach (APP) Receiver Selector

Selects the approach receiver to be monitored:

- APP L - Left ILS
- APP C - Center ILS
- APP R - Right ILS
- MKR - Marker beacon.

⑩ Navigation Filter Selector

Filters VOR, ADF, ILS, or DME audio:

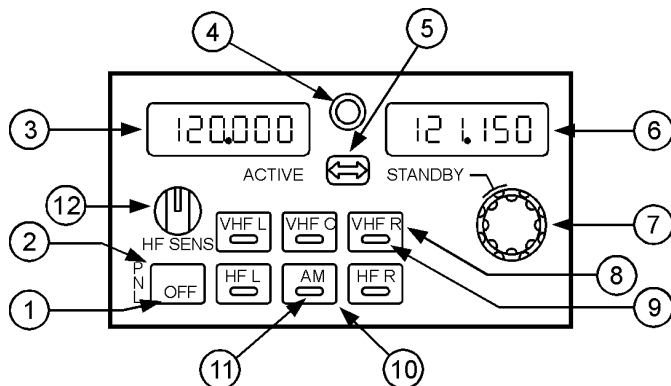
- V (voice) - Only the voice audio is heard
- B (both) - Both the voice and range audio are heard
- R (range) - Range audio (navigation aid Morse code identifier) is heard.

Note: Marker beacon audio and DME identifier are available in all positions.

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RADIO SYSTEM

Radio Tuning Panel



AFT AISLE STAND PANEL

77710048

- ① Radio Tuning Panel **OFF** Light

Illuminated - The radio tuning panel is off.

- ② Radio Tuning Panel (PNL) OFF Switch

Push - Disconnects the panel from the communication radios.

- ### ③ ACTIVE Frequency Window

Displays the tuned frequency of the selected radio.

Displays data if the selected radio is in the DATA mode (not applicable for VHF L).

- #### ④ Offside Tuning Light

Illuminated -

- The radio normally associated with this panel is being tuned by another radio tuning panel, or
- The radio tuning panel is being used to tune a radio not normally associated with this radio tuning panel.

Note: The left radio tuning panel is normally associated with VHF L and HF L. The right radio tuning panel is normally associated with VHF R and HF R. The center radio tuning panel is normally associated with VHF C.

⑤ Frequency Transfer Switch

Push -

- Transfers the STANDBY window frequency to the ACTIVE window and tunes the selected radio to the new active frequency
- Transfers the ACTIVE window frequency to the STANDBY window.

⑥ STANDBY Frequency Window

Displays the preselected or previously tuned frequency of the selected radio.

With data link installed, displays data when selection of the frequency transfer switch would reconfigure the selected radio to the DATA mode (not applicable for VHF L).

⑦ Frequency Selector

Rotate -

- Outer knob - Selects the portion of the STANDBY frequency to the left of the decimal point
- Inner knob - Selects the portion of the STANDBY frequency to the right of the decimal point

⑧ Radio Tuning Switches

Push -

- Selects the radio to be tuned
- The tuned frequency is displayed in the ACTIVE frequency window
- The standby frequency is displayed in the STANDBY frequency window.

⑨ Radio Tuning Lights

Illuminated - Indicates the selected radio.

⑩ AM Switch

Push - Sets the AM (Amplitude Modulation) or USB (Upper Side Band) mode for the selected HF.

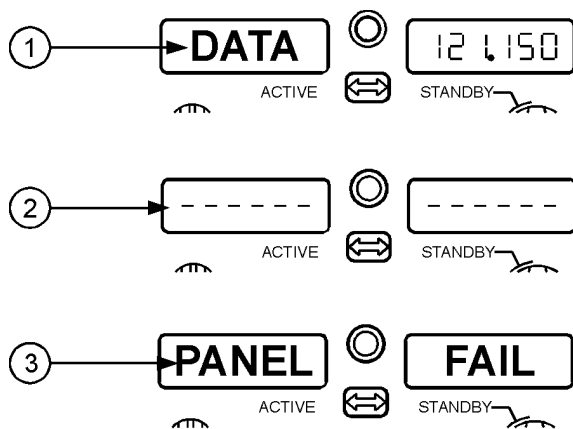
⑪ AM Light

Illuminated - HF AM is selected.

Extinguished - HF USB is selected.

⑫ HF Sensitivity Control

Rotate - Adjusts the sensitivity of the on-side HF receiver.

Radio Tuning Panel Indications

RADIO TUNING PANEL

77710049

① DATA Mode

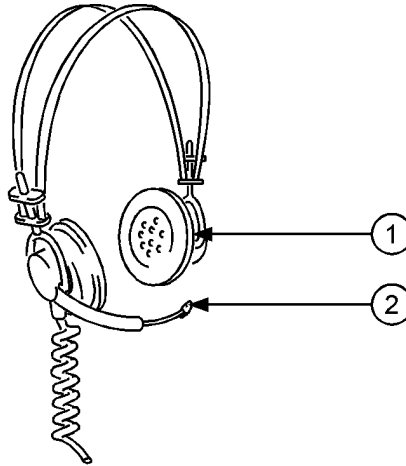
Displays data in the ACTIVE frequency window when the selected radio is being used in the DATA mode.

② RADIO FAIL

Displays dashes in both windows when the selected radio has failed or has been disconnected.

③ PANEL FAIL

The radio tuning panel is failed.

MISCELLANEOUS COMMUNICATION CONTROLS**Headphone / Boom Microphone (Typical)****SIDEWALL PANELS**

77710050

① Headphone

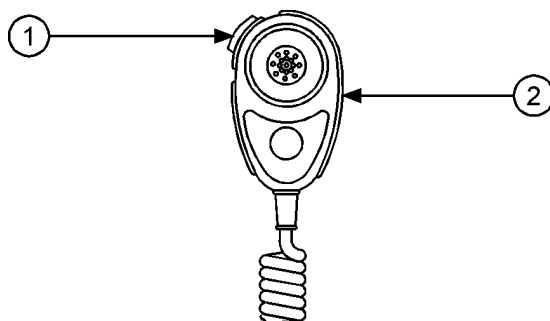
Used to monitor audio from the respective audio control panel.

Audio volume is adjusted using audio control panel controls for the associated station.

Available at all flight deck stations.

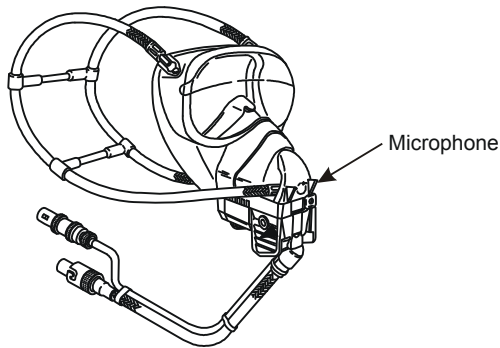
② Boom Mic

Activation of a control wheel, glareshield or audio control panel MIC/INTERPHONE switch transmits on the system selected for use at that station.

Hand Microphone (Typical)**SIDEWALL PANELS**

77710051

- ① Hand Microphone Push-To-Talk Switch
Push - Activates the hand microphone.
- ② Hand Microphone
Transmits on the system selected by the audio control panel.
Available at the captain, first officer and first observer stations.
Optional for the second observer station.

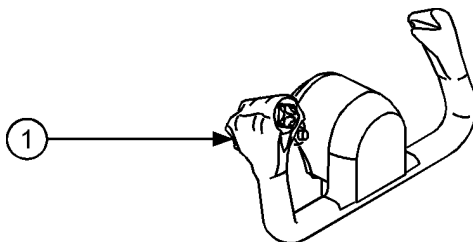
Oxygen Mask Microphone (Typical)

CREWMEMBER STATION (1 each)

77710052A

Enabled when the oxygen mask doors are open. The boom microphone is disabled.

Activation of a control wheel, glareshield or audio control panel
MIC/INTERPHONE switch transmits on the system selected for use at that station.

Control Wheel Microphone / Interphone Switch**CONTROL WHEELS**

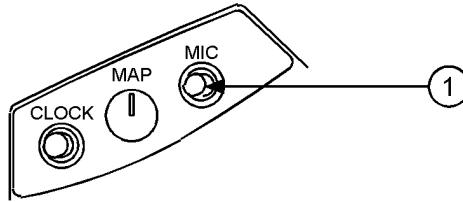
77710053

① Control Wheel MIC/INTERPHONE Switch

MIC - Allows transmission on the selected transmitter.

CENTER - Off position (spring-loaded to center).

INT - Allows transmission on the flight interphone system.

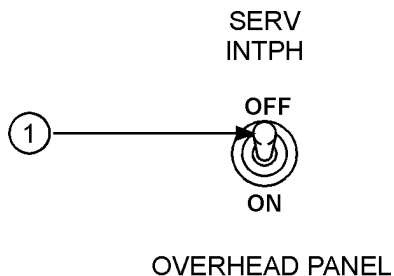
Glareshield Microphone Switch

GLARESHIELD PANEL

77710054

- ① Glareshield MIC Switch

Push - Allows transmission on the selected transmitter.

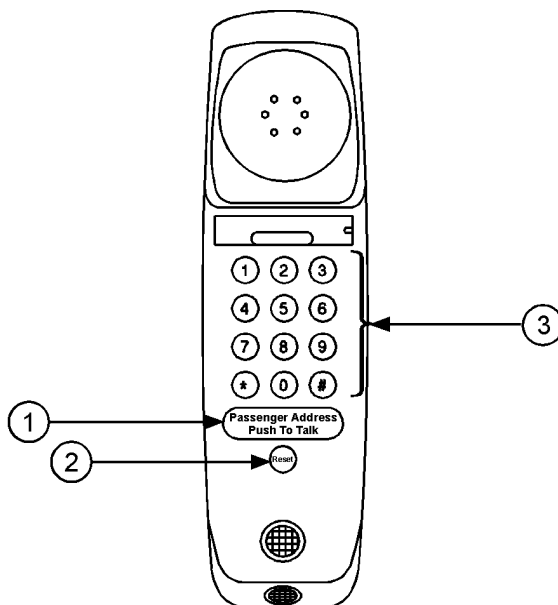
Service Interphone Switch

77710055

① Service Interphone Switch

OFF - Allows independent operation of the service and flight interphone systems.

ON - Connects the service and flight interphone systems.

Handset**AFT AISLE STAND PANEL**

77710056

① Handset PA Push To Talk Switch

Push -

- Connects the handset microphone to the selected PA area
- Only used in the PA mode.

② Handset RESET Switch

Push - Cancels a call or incorrectly selected code.

③ Handset Numeric Keys

Push - Selecting a code calls the respective station or PA area.

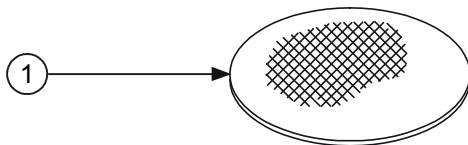
Note: Dial codes entered using the handset are not displayed on the CDU cabin interphone pages.

Flight Deck Handset Placard

<u>DIAL CODE DESCRIPTION</u>	<u>DIAL CODE</u>
EMERGENCY ALL CALL	54
PA OVERRIDE	4*
PA ALL	46
PA BUSINESS FIRST	41
PA ECONOMY	43
PA CREW REST	44
F/A ALL CALL	53
ISM / CREW REST	77
DOOR 1 AREA	71
DOOR 2 AREA	72
DOOR 3 AREA	73
DOOR 4 AREA	74
DOOR 1 LEFT	11
DOOR 2 LEFT	12
DOOR 3 LEFT	13
DOOR 4 LEFT	14
DOOR 1 RIGHT	21
DOOR 2 RIGHT	22
DOOR 3 RIGHT	23
DOOR 4 RIGHT	24
DOOR 3 X - AISLE	33
AFT GALLEY	34
PILOT CREW REST	91
GROUND CREW CALL	99

7775109

- ISM / CREW REST will dial the interphone at Door 1L to conference in the ISM with the Flight Deck and Crew Rest.
- Door 3 X-AISLE is an interphone mounted on the center-forward part of the cabin divider at Door 3.

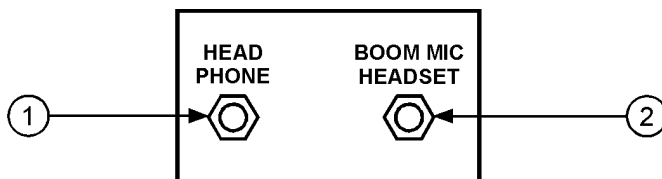
Flight Deck Speaker

LOWER SIDE PANELS

77710057

① Flight Deck Speaker

Controlled by the speaker volume control on the respective audio control panel.

Boom Microphone / Headphone Panel**LEFT & RIGHT SIDEWALL PANELS**

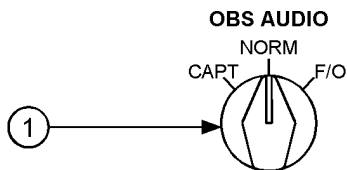
77710058

① Headphone Jack

Accepts a flight crew headset plug.

② Boom Mic Jack

Accepts a flight crew boom mic plug.

Observer Audio Selector**AFT AISLE STAND PANEL**

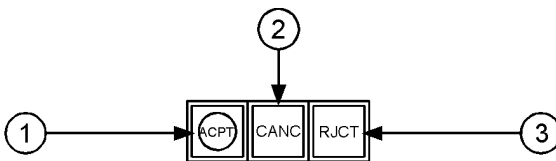
77710059

① Observer (OBS) AUDIO Selector

Captain (CAPT) - Connects the captain's hand microphone, headphone, boom microphone/headset, oxygen mask microphone, speaker, and mic/interphone switches to the first observer audio control panel.

Normal (NORM) - The first observer audio control panel is connected to the first observer's hand microphone, headphone, boom microphone/headset and oxygen mask microphone.

First Officer (F/O) - Connects the first officer's hand microphone, headphone, boom microphone/headset, oxygen mask microphone, speaker, and mic/interphone switches to the first observer audio control panel.

Data Link Accept / Cancel / Reject Switches**GLARESHIELD PANEL**

77710060

① Accept (ACPT) Switch

Push -

- A positive response to a displayed message is downlinked to the origin of the displayed message
- Functions the same as selecting an MFD communications display ACCEPT command key.

② Cancel (CANC) Switch

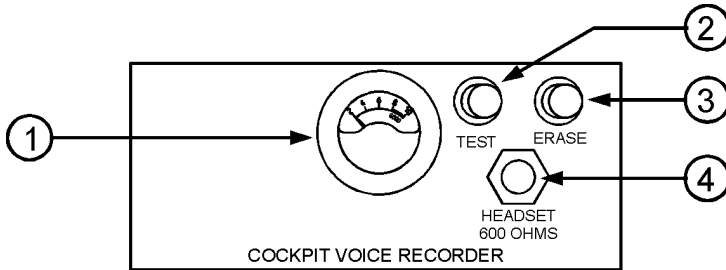
Push -

- The message is removed from the display
- Functions the same as selecting an MFD communications display CANCEL command key

③ Reject (RJCT) Switch

Push -

- A negative response to the displayed message is downlinked to the origin of the displayed message
- Functions the same as selecting an MFD communications display REJECT command key

COCKPIT VOICE RECORDER SYSTEM**Cockpit Voice Recorder Panel**

OVERHEAD MAINTENANCE PANEL

77710067

① Cockpit Voice Monitor Indicator

Pointer deflection indicates recording or erasure on all channels.

During test, the pointer rises into the green band.

② Cockpit Voice Recorder TEST Switch

Push and hold for five seconds - Tests all four cockpit voice recorder channels (1 per second).

③ Cockpit Voice Recorder ERASE Switch

Push and hold for three seconds - Erases the voice recorder (if on the ground, AC power on, and the parking brake is set).

④ Cockpit Voice Recorder Headset Jack

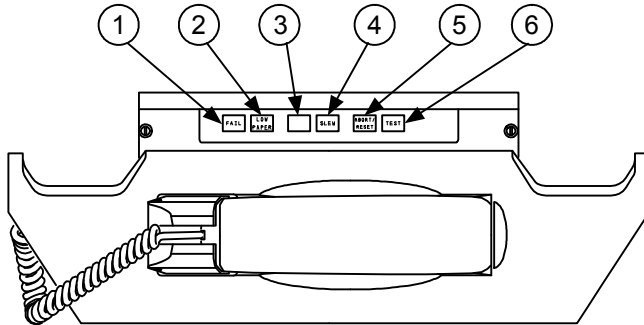
A headset may be plugged in to monitor playback of voice audio, or to monitor tone transmission during test.

Cockpit Voice Recorder Microphone

OVERHEAD PANEL

77710061

- ① Cockpit Voice Recorder Microphone
Area microphone for the voice recorder.

Printer Controls

AFT AISLE STAND PANEL

77710062

- ① Printer **FAIL** Light
Illuminated amber -
 - The printer is failed.
- ② Printer **LOW PAPER** Light
Illuminated **LOW PAPER** (amber):
 - The printer is low on paper.
Illuminated **PAPER** (amber):
 - The paper door is open, or
 - The paper is jammed.
- ③ Blank Key
- ④ Printer **SLEW** Switch
Push and hold - Advances the printer paper.

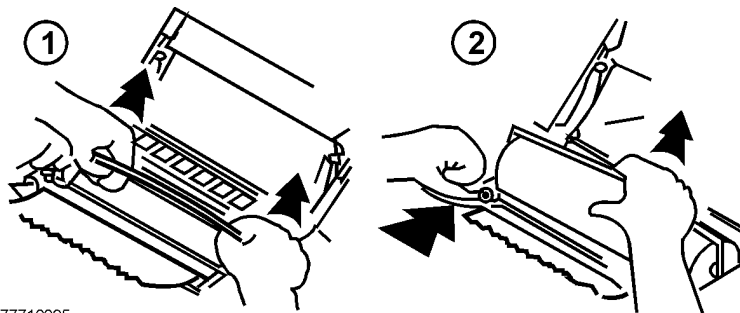
⑤ Printer RESET Switch

Push - Resets the printer if it stops operating.

⑥ Printer TEST Switch

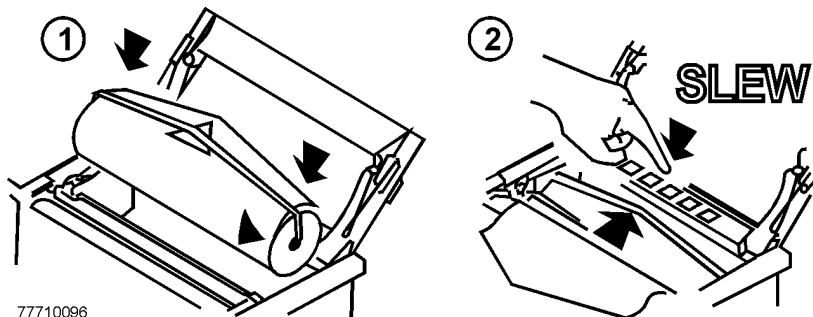
Push -

- Tests the printer and printer lights
- Prints a test pattern.

Paper Roll Removal

77710095

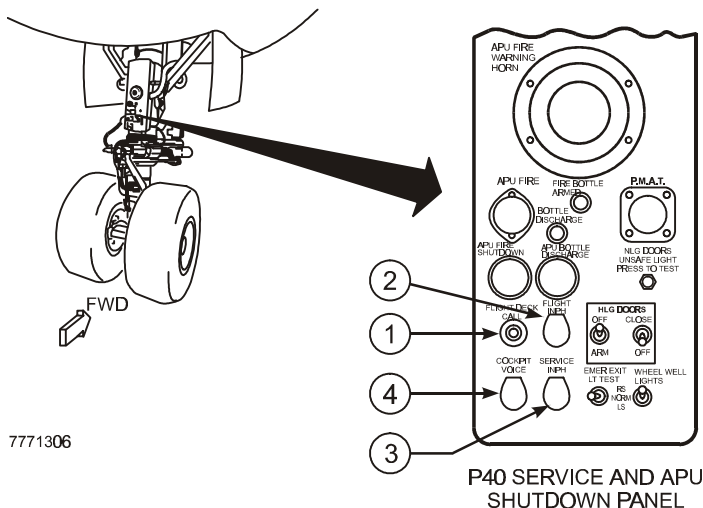
- ① Pull both sides of the blue strap to remove the paper roll.
- ② Pull the paper roll out while pushing gently on the green tab to release the paper.

Paper Loading

- ① Orient paper roll as shown. Press down on both sides of the paper roll.
- ② Turn the paper roll in the direction of the green arrow until the **PAPER** light turns off plus a little more.

Push the SLEW button until the paper exits. Paper will auto slew after 10 seconds.

P40 Service And APU Shutdown Panel



- ① **FLIGHT DECK CALL** – Activates the Flight Deck call chimes, illuminates the “CALL” prompt on the audio selector panel “FLT” key and displays the EICAS status message “GROUND CALL.”
- ② **FLIGHT INPH** – Allows ground personnel to communicate with the flight deck via the Flight Interphone system.
- ③ **SERVICE INPH** – Allows ground personnel to communicate with other areas of the aircraft (Flight Deck “SERV INTPH” switch must be ON).
- ④ **COCKPIT VOICE** – Allows ground personnel to monitor CVR audio inputs.

COMMUNICATIONS EICAS MESSAGES

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
ATC DATALINK LOST	Advisory		An established ATC datalink has been lost.
DATALINK LOST	Advisory		Datalink is temporarily lost.
DATALINK SYS	Advisory		Datalink system has failed.
RADIO TRANSMIT	Advisory		A VHF or HF radio is keyed for 30 seconds or more.
SATCOM	Advisory		SATCOM system has failed.
SATCOM DATALINK	Advisory		SATCOM datalink system has failed.
SATCOM DATALINK OFF	Memo		SATCOM system has a voice or data mode and the voice mode is selected.
SATCOM VOICE	Advisory		SATCOM voice communication has failed.
SATVOICE LOST	Advisory		SATCOM voice communication is temporarily lost.
VHF DATALINK	Advisory		VHF datalink system has failed.
VHF DATALINK OFF	Memo		Default datalink VHF radio is in voice mode.

LIST OF EFFECTIVE PAGES

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TOC-2	05/01/02			63	05/01/02
TOC-3	05/01/02	31	05/01/02	64	05/01/02
TOC-4	05/01/02	32	05/01/02	65	05/01/02
		33	05/01/02	66	05/01/02
1	05/01/02	34	05/01/02	67	05/01/02
* 2	11/01/02	35	05/01/02	68	05/01/02
3	05/01/02	36	05/01/02	69	05/01/02
4	05/01/02	37	05/01/02	70	05/01/02
5	05/01/02	38	05/01/02		
6	05/01/02	39	05/01/02	71	05/01/02
7	05/01/02	40	05/01/02	72	05/01/02
8	05/01/02			73	05/01/02
9	05/01/02	41	05/01/02	74	05/01/02
10	05/01/02	42	05/01/02	75	05/01/02
		43	05/01/02	76	05/01/02
11	05/01/02	44	05/01/02	77	05/01/02
12	05/01/02	45	05/01/02	78	05/01/02
13	05/01/02	46	05/01/02	79	05/01/02
14	05/01/02	47	05/01/02	80	05/01/02
15	05/01/02	* 48	11/01/02		
* 16	11/01/02	49	05/01/02	81	05/01/02
17	05/01/02	50	05/01/02	82	05/01/02
18	05/01/02			83	05/01/02
19	05/01/02	51	05/01/02	84	05/01/02
20	05/01/02	52	05/01/02	85	05/01/02
		53	05/01/02	86	05/01/02
21	05/01/02	54	05/01/02	87	05/01/02
22	05/01/02	55	05/01/02	88	05/01/02
23	05/01/02	56	05/01/02	89	05/01/02
24	05/01/02	57	05/01/02	90	05/01/02
25	05/01/02	* 58	11/01/02		
26	05/01/02	59	05/01/02	91	05/01/02
27	05/01/02	60	05/01/02	92	05/01/02
28	05/01/02			93	05/01/02
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ELECTRICAL SYSTEM DESCRIPTION**INTRODUCTION**

The electrical system generates and distributes AC and DC power to other airplane systems, and is comprised of: main AC power, backup power, DC power, standby power, and flight controls power. System operation is automatic. Electrical faults are automatically detected and isolated.

AC ELECTRICAL SYSTEM

The AC electrical system is the main source for airplane electrical power.

Electrical Load Management System (ELMS)

The ELMS provides load management and protection to ensure power is available to critical and essential equipment.

With only one generator available or if the electrical loads exceed the power available (airplane or external), ELMS automatically sheds AC loads by priority until the loads are within the capacity of the airplane or ground power generators. The load shedding is galleys first, then utility busses. Utility busses are followed by individual equipment items powered by the main AC busses. When an additional power source becomes available or the loads decrease, ELMS restores power to shed systems (in the reverse order). The message **LOAD SHED** displays on the electrical synoptic during load shed conditions.

AC Electrical System Power Sources

The entire airplane AC electrical load can be supplied by any two main AC power sources.

The main AC electrical power sources are:

- Left and right engine Integrated Drive Generators (IDGs)
- APU generator
- Primary and secondary external power.

The power sources normally operate isolated from one another. During power source transfers on the ground (such as switching from the APU generator to an engine generator) operating sources are momentarily paralleled to prevent power interruption.

Integrated Drive Generators (IDGs)

Each engine has an IDG. Each IDG has automatic control and system protection functions.

When an engine starts, with the GENERATOR CONTROL switch selected ON, the IDG automatically powers the respective main bus. The previous power source is disconnected from that bus.

The IDG can be electrically disconnected from the busses by pushing the GENERATOR CONTROL switch to OFF. The IDG can also be electrically disconnected from its respective bus by selecting an available external power source prior to engine shutdown. (See Primary External Power and Secondary External Power in this section.)

The **DRIVE** light illuminates and the EICAS message **ELEC GEN DRIVE L** or **R** displays when low oil pressure is detected in an IDG. The IDG drive can be disconnected from the engine by pushing the respective DRIVE DISCONNECT switch. The IDG cannot be reconnected by the flight crew.

High drive temperature causes the IDG to disconnect automatically.

APU Generator

The APU generator is electrically identical to the IDG generators. The APU generator can power either or both main busses, and may be used in flight as a replacement to an IDG source.

If no other power source is available when the APU generator becomes available, the APU generator automatically connects to both main AC busses. If the primary external source is powering both main busses, the APU powers the left main bus, and the primary external source continues to power the right main bus. The APU generator and the secondary external source cannot both provide power to the aircraft at the same time.

The APU generator **OFF** light illuminates when the APU is operating and the APU generator breaker is open because of a fault or the APU GENERATOR switch is selected OFF. When the APU GENERATOR switch is ON and a fault is detected, the APU generator cannot connect to the busses.

In flight, when both transfer busses are unpowered, the APU starts automatically, regardless of selector position.

Primary External Power

Primary external power can power the left and right main busses. When the primary power source voltage and frequency are within limits, the primary external power **AVAIL** (available) light illuminates. If no AC power is applied, either external power source will power the airplane.

If no other source is powering the main busses, pushing the PRIMARY EXTERNAL POWER switch ON connects primary external power to both main busses. When primary external power is connected to a main bus, the **PRIMARY EXTERNAL POWER ON** light illuminates and the **AVAIL** light extinguishes.

If a single IDG powers both busses, pushing the PRIMARY EXTERNAL POWER switch ON connects primary external power to both busses and removes the IDG source.

If both IDGs are powering their respective busses, the APU generator is NOT running and secondary external power is NOT available, pushing the PRIMARY EXTERNAL POWER switch ON connects primary external power to both busses and removes the IDG sources.

If both IDGs are powering their respective busses, and secondary external power is available, pushing the PRIMARY EXTERNAL POWER switch to ON connects primary external power to the right main bus, leaving the left main bus powered from the left IDG.

If the APU generator is running, pushing the PRIMARY EXTERNAL POWER switch ON connects primary external power to the right main bus, leaving the previous source connected to the left main bus.

If both busses are powered from secondary external power, pushing the PRIMARY EXTERNAL POWER switch ON connects primary external power to the right main bus, leaving secondary external power connected to the left main bus.

Pushing the PRIMARY EXTERNAL POWER switch while primary external power is ON, disconnects primary external power. The previously connected power source is reconnected, if available.

Secondary External Power

Secondary external power can power the left and right main busses. When the secondary external power source voltage and frequency are within limits, the secondary external power **AVAIL** (available) light illuminates.

If no AC power is applied, the BATTERY switch must be ON or primary external power must be available for secondary external power to power the airplane. If the BATTERY switch is ON and no other source is powering the main busses, pushing the SECONDARY EXTERNAL POWER switch ON connects secondary external power to both main busses. When secondary external power is connected to a main bus, the **SECONDARY EXTERNAL POWER ON** light illuminates and the **AVAIL** light extinguishes.

If a single IDG powers both main busses, pushing the SECONDARY EXTERNAL POWER switch ON connects secondary external power to both busses and removes the IDG source. Similarly, if only secondary external power is available and both IDGs are powering their respective busses, pushing the SECONDARY EXTERNAL switch ON connects secondary external power to the left main bus. When the right engine is shut down, there is an uninterrupted transfer of secondary external power to the right main bus.

If both IDGs are powering their respective busses, and both secondary and primary external power are available, pushing the SECONDARY EXTERNAL POWER switch ON connects secondary external power to the left main bus, leaving the right main bus powered from the right IDG.

If the APU generator is running, pushing the SECONDARY EXTERNAL POWER switch ON connects secondary external power to the left main bus, leaving the right IDG or primary external power connected to the right main bus.

If both busses are powered from primary external power, pushing the SECONDARY EXTERNAL POWER switch ON connects secondary external power to the left main bus, leaving primary external power connected to the right main bus.

Pushing the SECONDARY EXTERNAL POWER switch while secondary external power is ON disconnects secondary external power. The previously connected power source is reconnected, if available.

AC Electrical Power Distribution

AC power is distributed through the left and right main busses and the ground service bus.

AC Main Busses

The right IDG normally powers the right main bus and the left IDG normally powers the left main bus. The APU normally powers both main busses when they are not powered by any other source.

When external power is connected:

- Primary external power normally powers the right main bus
- Secondary external power normally powers the left main bus.

Bus tie relays, controlled by BUS TIE switches, isolate or parallel the right and left main busses. When both BUS TIE switches are set to AUTO, the bus tie system operates automatically to maintain power to both main busses.

Power transfers are made without interruption when the airplane is on the ground, except when switching between primary and secondary external power sources.

The source order for powering left and right main busses in flight is the:

- Respective IDG
- APU generator
- Opposite IDG.

The main busses power individual equipment items such as:

- Cooling vent fan
- Recirculation fans
- Lavatory/galley fans
- Electric hydraulic pumps
- Passenger entertainment systems

Each main bus also powers its associated busses (typical loads are shown in parentheses):

- Transfer bus (DC system transformer-rectifiers, AC standby bus)
- Utility bus (forward galley heater, chiller boost fan, gasper fan, captain's and first officer's foot and shoulder heaters, door area heaters, lavatory water heaters and shavers)
- Galley busses.

Ground Service Bus

The ground service bus is normally powered by the right main AC bus. Alternate sources of power for the ground service bus, in priority, are:

- Primary external power
- The APU generator.

The ground service bus powers:

- The main battery charger
- The APU battery charger
- Miscellaneous cabin and system loads
- Left forward AC fuel pump.

Ground Handling Bus

The ground handling bus can be powered on the ground only from the primary external power source (has priority), or the APU generator. It is provided for loads such as cargo handling, fueling / defueling operations, and equipment energized only during ground operations.

Cabin Systems Power (As Installed)

Electrical power to cabin systems is controlled from the flight deck.

IFE And Passenger Seats Power Control

Electrical power to the in-flight entertainment (IFE) system and passenger seats is controlled by the IFE/PASS SEATS power switch on the electrical panel. With the switch ON, the IFE system and all passenger seats and related systems are powered normally.

Pushing the IFE/PASS SEATS power switch OFF removes power from the following:

- IFE (all components)
- Passenger seats (including seat motor power, personal computer power outlets, and telephones).

Cabin And Utility Systems Power Control

Electrical power to various cabin and utility systems is controlled by the CABIN/UTILITY power switch on the electrical panel. With the switch ON, the ground service bus, utility busses, and galleys are powered normally.

Pushing the CABIN/UTILITY power switch OFF removes power from items such as:

- Ground service bus (except main and APU battery chargers, and left forward fuel pump)
- Utility busses
- Galleys
- Fluorescent cabin lighting
- Beacon, logo, and wing lights.

Additionally, when the CABIN/UTILITY power switch is selected OFF, the following cabin lights are turned on:

- Night lights, supplemental night lights, and reading lights
- Attendant work lights and some galley / crew rest lights.

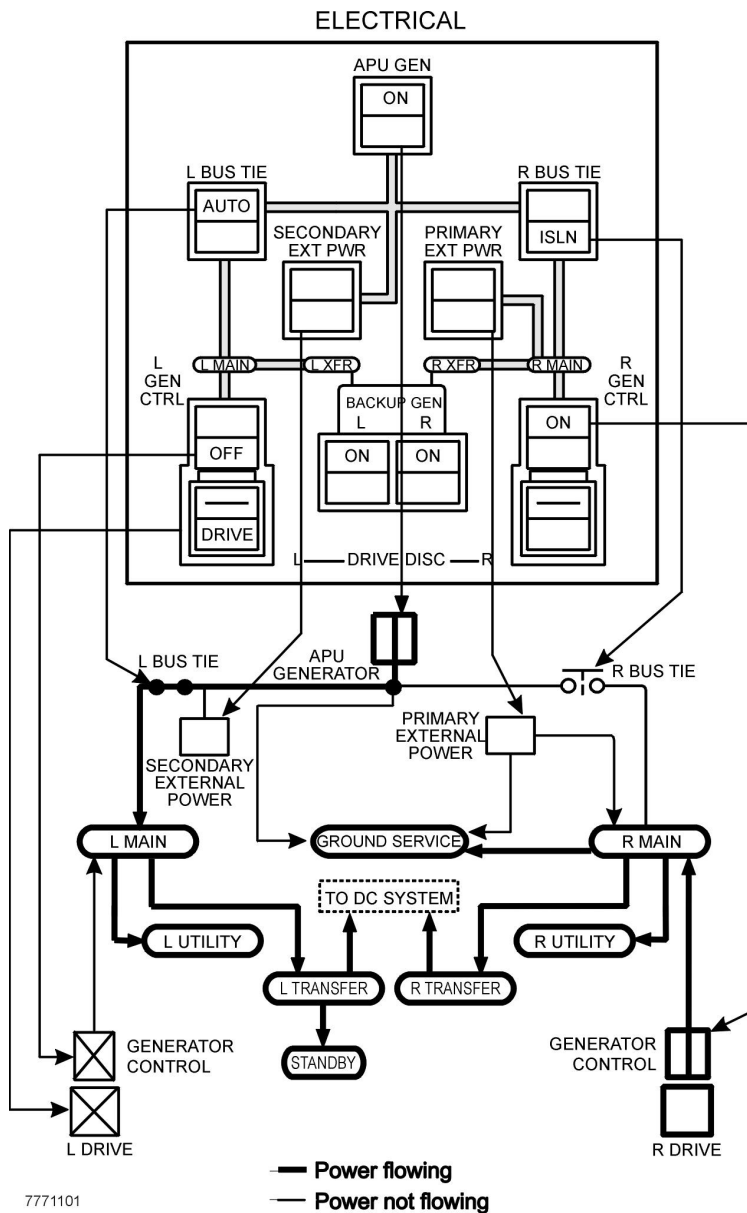
Autoland

During autoland, the busses isolate to allow three independent sources to power the three autopilot systems:

- The left IDG powers the left AC transfer bus, the left main DC bus, and the Captain's flight instrument bus
- The right IDG powers the battery bus and AC standby bus through the main battery charger
- The backup system powers the right AC transfer bus, the right DC bus, and the First Officer's flight instrument bus.

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AC Electrical System Schematic



Backup AC Electrical System

The backup electrical system is designed to automatically provide power to selected airplane systems. The system transfers power without interruption. The backup electrical system automatically powers one or both transfer busses when:

- Only one main AC generator (includes APU) is available
- Power to one main AC bus is lost
- Power to both main AC busses is lost
- Approach (APP) mode is selected for autoland

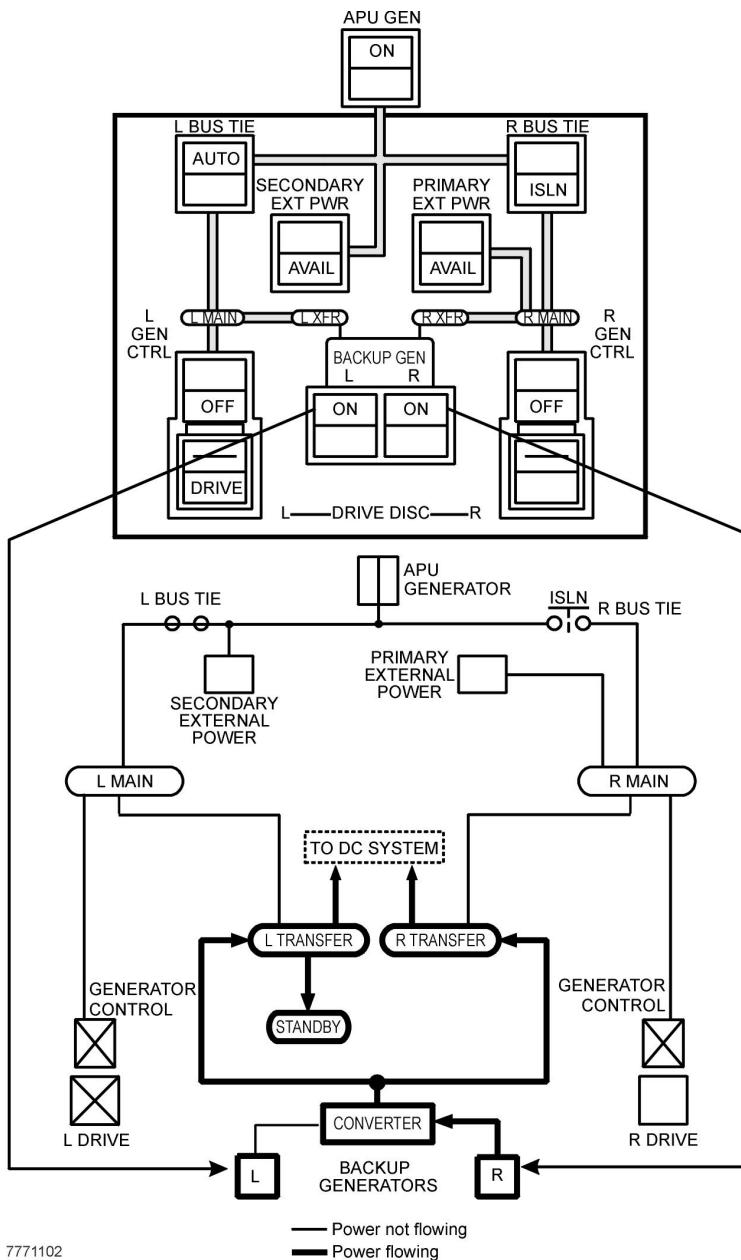
The system is automatically tested after engine starts.

Backup Generators

Backup power is provided by one variable speed, variable frequency generator mounted on each engine. A frequency converter converts the generator frequency to a constant 400 Hz. Only one backup generator can power the converter at a time.

Each backup generator contains two permanent magnet generators (PMGs) that supply power to the flight control DC electrical system (refer to DC Electrical System).

Backup AC Electrical System Schematic



DC ELECTRICAL SYSTEM

The DC electrical system includes the main DC electrical system and the flight control DC electrical system.

Main DC Electrical System

The main DC electrical system uses transformer-rectifier units (TRUs) to produce DC power. The TRUs are powered by the AC transfer busses.

Main DC Power Distribution

TRU DC electrical power is distributed to the left and right main DC busses.

The left TRU powers the left main DC bus. The left main bus provides a second DC power source for:

- The left flight control bus
- The right main DC bus.

The right TRU powers the right main DC bus. The right main bus provides a second DC power source for:

- The right flight control bus
- The left main DC bus.

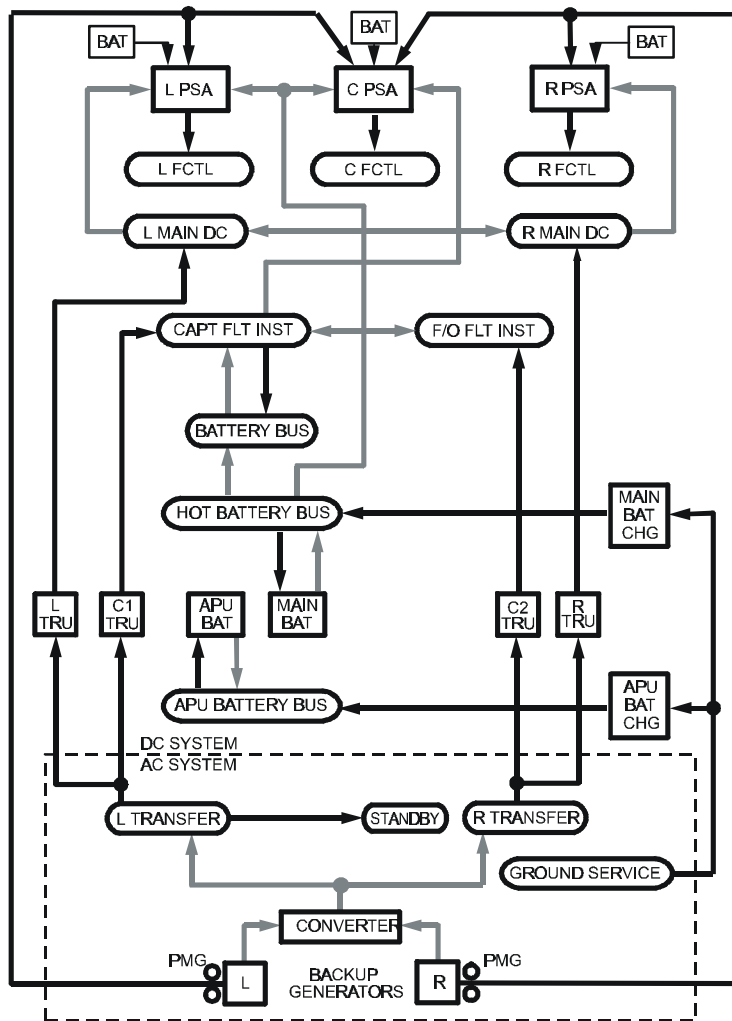
The C1 TRU powers the Captain's flight instrument bus and the battery bus. The Captain's flight instrument bus provides a second DC power source for:

- The center flight control bus
- The First Officer's flight instrument bus
- The standby inverter.

The C2 TRU powers the First Officer's flight instrument bus. The First Officer's flight instrument bus provides a second DC power source for the Captain's instrument bus.

The hot battery bus is connected directly to the main battery.

DC And Flight Control Electrical Systems Schematic



Flight Control DC Electrical System

The flight control DC electrical system is a dedicated power source for the primary flight control system.

Primary power for the flight control DC electrical system comes from permanent magnet generators (PMGs) housed within each backup generator. Variable frequency PMG AC power is used by individual power supply assemblies (PSAs) to provide DC power to the three flight control DC busses.

To ensure a high level of system reliability, each PSA also has multiple DC power sources. If primary PMG AC power is not available, secondary power for the left and right PSAs, is provided by the related main DC bus. Secondary power for the center PSA is provided by the Captain's flight instrument bus. The hot battery bus provides additional backup power for the left and center PSAs only.

Each PSA also uses a dedicated battery to prevent power interruptions to the related flight control DC bus. The batteries have limited capacity and are incorporated to supply power for brief periods during PSA power source transfers. These batteries are capable of supplying power for one minute.

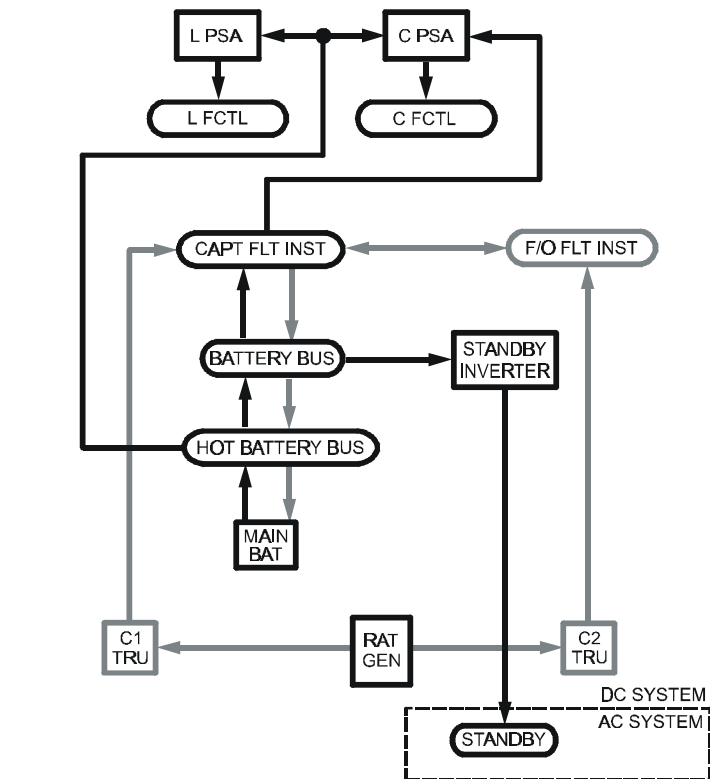
Standby Electrical System

The standby electrical system can supply DC and AC power to selected flight instruments, communications and navigation systems, and the flight control system, if there are primary AC and DC electrical power system failures.

The standby electrical system consists of:

- The main battery
- The standby inverter
- The RAT generator and its associated generator control unit
- The C1 and C2 TRUs.

Standby Electrical System Schematic



Standby power (battery only available).

Additional standby power (RAT GEN available).

RAT GEN -- ram air turbine generator

FCTL -- flight control DC bus

FLT INST -- flight instrument bus

PSA -- power supply assembly

Main Battery

The main battery provides standby power to the following:

- The hot battery bus
- The battery bus
- The left and center flight control busses
- The Captain's flight instrument bus
- The standby inverter (which powers the AC standby bus).

The main battery charger, when powered, powers the hot battery bus.

Standby Inverter

The standby inverter converts DC power to AC power. The inverter powers the AC standby bus if the left transfer bus is not powered.

Ram Air Turbine (RAT) Generator

The RAT generator provides standby power to the C1 and C2 TRUs. The RAT generator has no operating time limits, and operates at all airspeeds and altitudes.

The RAT can supply electrical and hydraulic power simultaneously. If the RAT is unable to maintain RPM, the RAT generator electrical load is shed until RPM is satisfactory. Power for standby electrical loads is provided by the main battery when the RAT generator loads are shed.

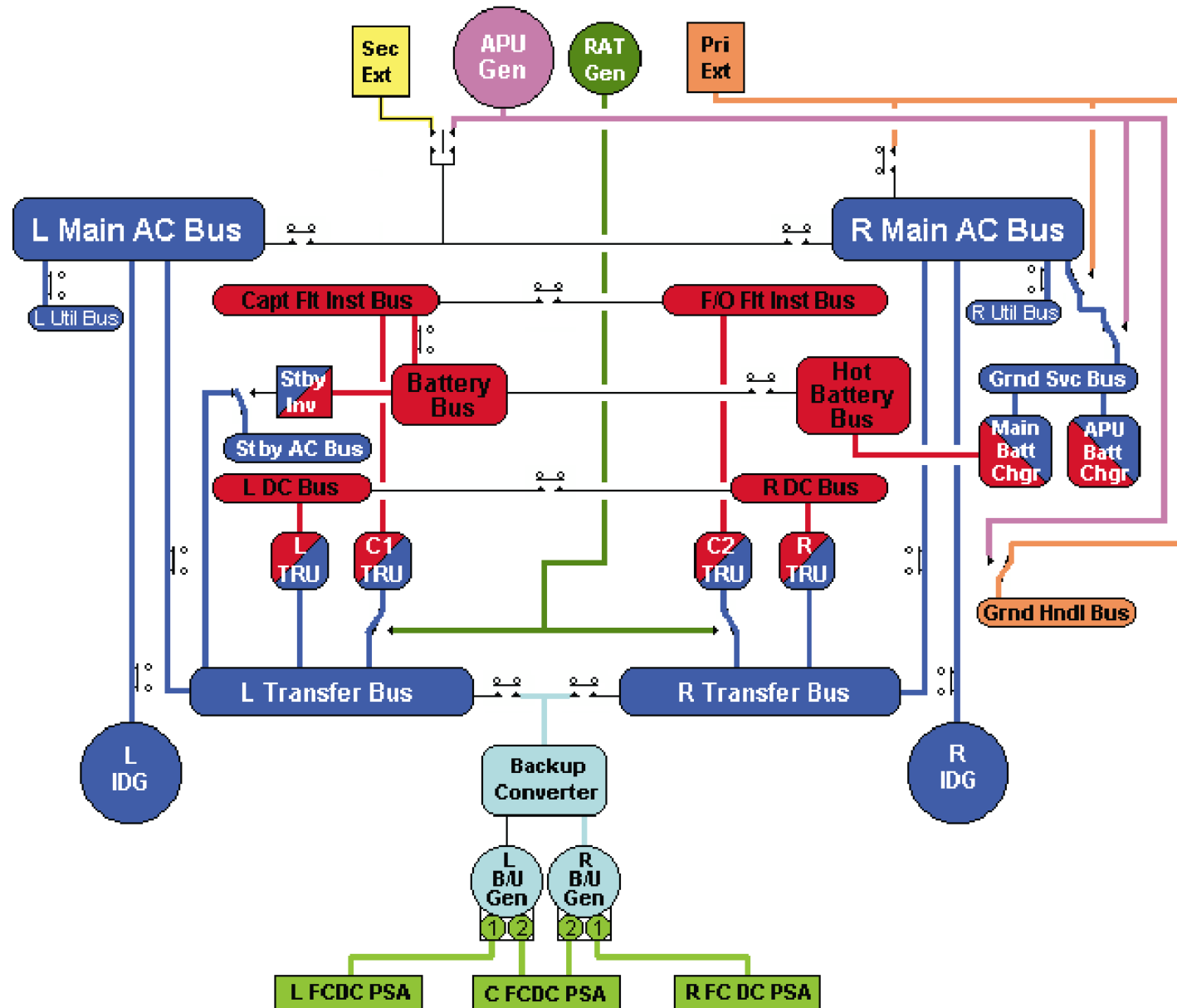
The RAT is deployed automatically if both AC transfer busses lose power in flight. The RAT can be manually deployed by pushing the RAM AIR TURBINE switch on the overhead panel.

Warning: The RAT can be deployed manually on the ground. Deployment could cause seriously injury to ground personnel or damage to ground equipment.

RAT deployment and operation are described in Section 6.13, Hydraulics.

APU Battery

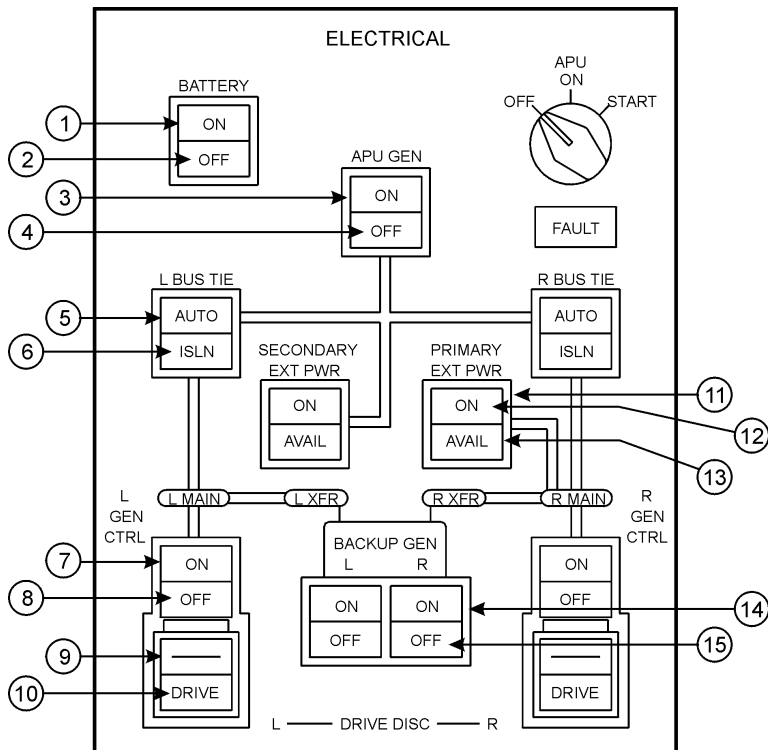
The APU battery provides power for the APU control circuitry, and for starting the APU if the APU air turbine starter is not available. The APU is automatically started if both AC transfer busses lose power in flight (regardless of APU selector position). Refer to Section 6.7, Engine & APU, for APU starter operation.



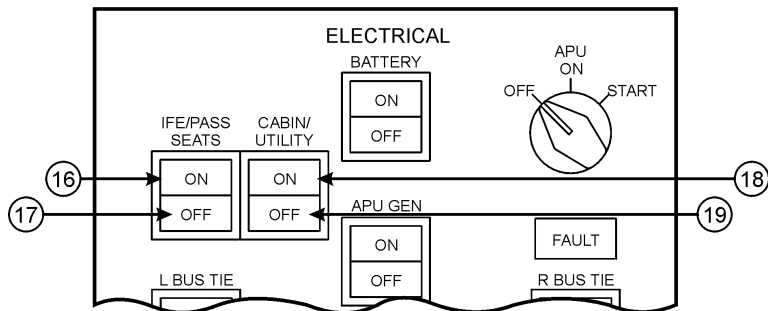
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CONTROLS AND INDICATORS

Electrical Panel



As Installed



OVERHEAD PANEL

① BATTERY Switch

ON -

- Unpowered airplane on the ground:
 - A few switch annunciator lights illuminate
 - Allows the APU to be started
 - No displays are powered.
- Powered airplane in flight or on the ground when AC power is removed or lost:
 - The standby busses and emergency lighting are powered
 - The left inboard, outboard, and upper center displays, and the left CDU are powered.

OFF - turns battery power off. In flight, the EICAS message **ELEC BATTERY OFF** displays.

② Battery OFF Light

Illuminated (amber) - The battery switch is OFF.

③ APU Generator (APU GEN) Switch

ON - Arms APU generator breaker to automatically close.

OFF - Opens APU generator breaker.

④ APU Generator OFF Light

Illuminated (with the APU running) (amber) -

- The APU generator breaker is open because of a fault, or
- The APU GENERATOR switch is selected OFF.

⑤ BUS TIE Switches

AUTO - Arms automatic AC bus tie circuits.

ISLN (isolation) (AUTO not visible) - Commands the bus tie open.

⑥ Bus Isolation (ISLN) Lights

Illuminated (amber) -

- Bus tie breaker is locked open (ISLN selected with bus tie switch), or
- A fault has occurred, automatically opening the bus tie breaker.

⑦ Generator Control (GEN CTRL) Switches

ON - Arms the generator breaker to close automatically when generator power is available.

OFF -

- Opens field and generator breakers
- Resets fault trip circuitry.

⑧ Generator **OFF** Lights

Illuminated (amber) - The generator breaker is open.

⑨ Drive Disconnect Switches

Push -

- Disconnects the integrated drive generator (IDG) input from the engine
- Requires maintenance action on the ground to reconnect the IDG.

⑩ Generator **DRIVE** Lights

Illuminated (amber) - IDG oil pressure is low.

⑪ External Power (EXT PWR) Switches

Push - If **AVAIL** light is illuminated, closes external power contactor. Subsequent action opens external power contactor.

ON - External power is connected to the bus(es).

OFF (ON not visible) - External power is disconnected from the bus(es).

⑫ External Power **ON** Lights

Illuminated - external power is powering the busses.

⑬ External Power **AVAIL** Lights

Illuminated -

- External power is plugged in and power quality is acceptable
- Extinguishes when the **ON** light illuminates.

14 Backup Generator (BACKUP GEN) Switches

ON - Backup generator operation is armed.

OFF -

- Opens the backup generator control relay
- Resets the fault circuitry.

15 Backup Generator **OFF** Lights

Illuminated (amber) -

- The backup generator has failed, or
- A circuit fault has been detected, or
- Backup generator switch selected off, or
- Both **OFF** lights illuminated - backup system (converter) has failed.

Cabin Systems Power (As Installed)**16** In-Flight Entertainment System / Passenger Seats (IFE/PASS SEATS) Power Switch

ON – Powers IFE and passenger seat systems when AC power is available.

OFF – Removes power from IFE and passenger seat systems.

17 IFE/PASS SEATS **OFF** Light

Illuminated (amber) – The IFE/PASS SEATS power switch is OFF.

18 Cabin / Utility (CABIN/UTILITY) Power Switch

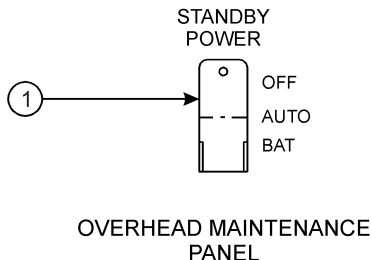
ON – Powers cabin and utility systems when AC power is available.

OFF – Removes power from cabin and utility systems and turns on some cabin lighting.

19 CABIN/UTILITY Power **OFF** Light

Illuminated (amber) – CABIN/UTILITY power switch is selected OFF.

Overhead Maintenance Panel Standby Power Switch



7771106

① STANDBY POWER Switch

Note: Ground operation only.

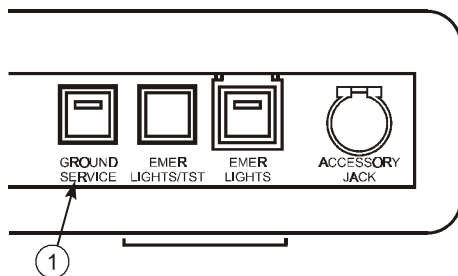
OFF - The AC standby bus is not powered.

AUTO (guarded) - The standby busses transfer to battery power if normal AC power is lost.

BAT (momentary) -

- The standby busses are powered from the battery if AC power is not available
- Initiates a DC / standby self-test if AC power is available.

Flight Attendant Switch Panel (Door 1L)



77766001

① GROUND SERVICE Switch

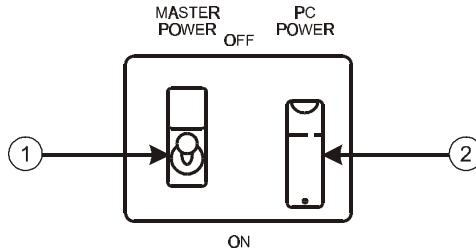
Note: Switch operates only if right main AC bus is not powered.

PUSH – Light bar illuminated.

- Connects AC ground service bus to primary external power or APU generator.

IFE Master Power And PC Power Switches

(Panel above Purser Station)



7776-6002

① MASTER POWER Switch

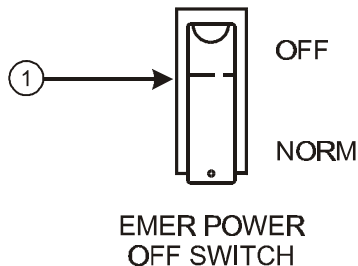
ON (guarded) – Powers the inflight entertainment system when AC power is available.

OFF – Removes all electrical power from the inflight entertainment system.

② PC POWER Switch

ON (guarded) – Provides power for passenger seats (including personal computer outlets and telephones).

OFF – Removes all electrical power from passenger seats, computer outlets, and telephones.

Galley Emergency Power Off Switch

7776-6003

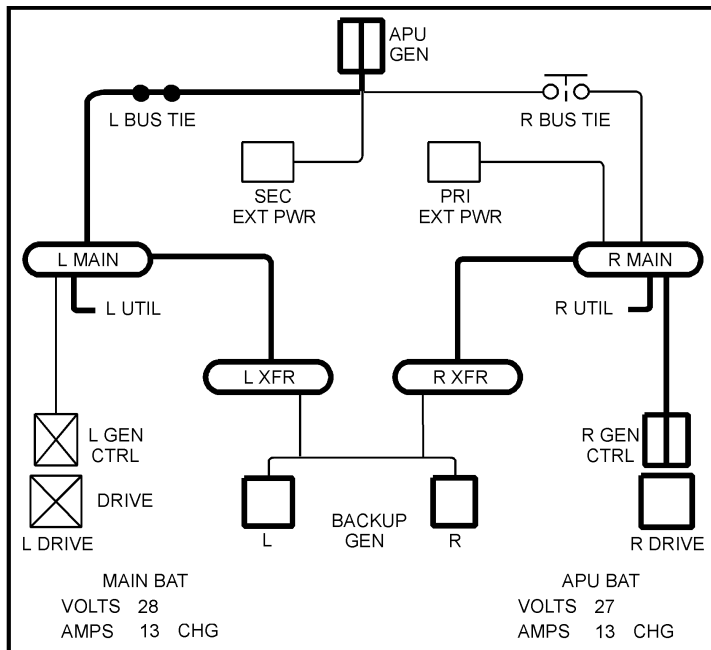
① EMER POWER OFF Switch

Note: One each galley.

NORM (guarded) – Powers respective galley when AC power is available.

OFF – Removes all electrical power from the respective galley.

Electrical Synoptic Display



MULTIFUNCTION DISPLAY

CHG - battery charging
CTRL - control
DISCH - battery
discharging
DRIVE - oil pressure low
(amber)

Drive disconnected
(engine running)
(amber)

On or available
(green)

Off (white)

Not supplying
power or failed
(amber)

Power flowing
(green)

Power not flowing
(white)

7771108

The electrical synoptic is displayed by pushing the ELEC synoptic display switch on the display select panel. Display select panel operation is described in Section 6.10, Flight Instruments, Displays.

Electrical EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
ELEC AC BUS L, R	Caution	Beeper	AC bus is unpowered.
ELEC BACKUP GEN L, R	Advisory		Backup generator has failed.
ELEC BACKUP SYS	Advisory		Backup power system has failed.
ELEC BATTERY OFF	Advisory		Battery switch is OFF.
ELEC BUS ISLN L, R	Advisory		Bus tie breaker is not in the commanded position or bus isolation switch is OFF.
ELEC CABIN/UTIL OFF (As Installed)	Advisory		CABIN UTILITY power switch is OFF.
ELEC GEN DRIVE L, R	Advisory		Generator drive oil pressure is low.
ELEC GEN OFF APU	Advisory		APU generator control breaker is open.
ELEC GEN OFF L, R	Advisory		Generator control breaker is open.
ELEC GND HDLG BUS	Advisory		Ground handling bus relay has failed.
ELEC IFE/SEATS OFF (As Installed)	Advisory		IFE/PASS SEATS power switch is OFF.

Message	Level	Aural	Condition
ELEC STANDBY SYS	Advisory		A fault is detected in the standby power system.
MAIN BATTERY DISCH	Advisory		Main battery is discharging or hot battery bus is unpowered.

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LIST OF EFFECTIVE PAGES

PAGE	DATE	PAGE	DATE	PAGE	DATE
* TOC-1	11/01/02				
* TOC-2	11/01/02				
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3	05/01/02				
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* Asterisk indicates page(s) revised or added by the current revision.

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ENGINES & APU SYSTEM DESCRIPTION**ENGINES****Introduction**

The airplane is powered by two General Electric Model GE90-90B engines. The engines are rated at 90,000 pounds of takeoff thrust each.

The engines are dual rotor axial flow turbofans of high compression and bypass ratio. The N_1 rotor consists of a fan, a low-pressure compressor section, and a low-pressure turbine section on a common shaft. The N_2 rotor consists of a high-pressure compressor section and a high-pressure turbine section on a common shaft. The N_1 and N_2 rotors are mechanically independent. The N_2 rotor drives the engine accessory gearbox.

Each engine is controlled by an electronic engine controller (EEC). The EECs monitor autothrottle and flight crew inputs through the thrust levers to automatically control the engines.

Each engine has individual flight deck controls. Thrust is set by positioning the thrust levers. The thrust levers are positioned automatically by the autothrottle system or manually by the flight crew. See Section 6.11, Flight Management, Navigation for a description of FMC thrust management functions.

Engine indications are displayed on the engine indication and crew alerting system (EICAS) display.

Engine Intermix

Both engines are set to operate at the same thrust rating. Replacement engine thrust rating is increased or decreased to match the thrust rating of the installed engine configuration. An EGT difference between the engines may be indicated when operating at high thrust settings. These indications are normal. Engine limit indications are not affected when engines are intermixed.

Engine Indications

Primary and secondary engine indications are provided. Engine indications are displayed on the EICAS display and any selected Multifunction Display (MFD).

Primary Engine Indications

N₁ and EGT are the primary engine indications. The primary engine indications are always displayed on the EICAS display. Normally the EICAS is on the upper center display unit. If that unit fails, the EICAS display automatically moves to the lower center display unit.

Secondary Engine Indications

N₂, fuel flow, oil pressure, oil temperature, oil quantity, and engine vibration are secondary engine indications. Secondary engine indications are displayed on the selected MFD. The secondary engine indications can be displayed by pushing the secondary engine display switch (the ENG switch on the display select panel). The secondary engine indications are automatically displayed when:

- The displays initially receive electrical power
- A FUEL CONTROL switch is moved to CUTOFF in flight
- An engine fire switch is pulled in flight
- A secondary engine parameter is exceeded, or
- Engine N₂ RPM is below idle in flight.

When the secondary engine parameters are automatically displayed (on the lower MFD, if available) due to any of the above conditions, they cannot be cleared until the condition is no longer present. Once the condition is no longer present, the secondary engine parameters can be cleared by pushing the secondary engine display switch.

Normal Display Format

Primary engine indications and the N_2 indications are both digital readouts and round dial/moving pointer indications. The digital readouts display numerical values while the moving pointers indicate relative value.

Oil pressure, oil temperature, and vibration indications are both digital readouts and vertical indication/moving pointers. Fuel flow and oil quantity are digital readouts only. All digital readouts are enclosed by boxes. The dial and vertical indications display the normal operating range, caution range, and operating limits (as applicable).

The oil temperature and oil pressure vertical indication has caution ranges displayed by amber bands. If oil temperature or oil pressure reaches the caution range, the digital readout, digital readout box, and pointer all change color to amber.

N_1 , N_2 , EGT, oil pressure, and oil temperature indications have operating limits indicated by red lines. If one of these indications reaches the red line, the digital readout, box, and pointer change color to red for that indication.

The EGT indication has a maximum continuous limit represented by an amber band. If EGT reaches the maximum continuous limit, the digital indication, box, pointer, and dial all change color to amber. EGT indications are inhibited from changing to amber during takeoff or go-around for five minutes. The EGT indication has a maximum takeoff limit displayed by a red line. If EGT reaches the maximum takeoff limit, the digital indication, box, pointer and dial, all change color to red.

If an N_1 , N_2 , or EGT red line is exceeded, the box enclosing the digital readout remains red after the exceeded limit returns to the normal range. The red box color can be canceled to white or recalled to red by pushing the cancel/recall switch on the display select panel. An indication changes color back to white when it returns to the normal operating range.

For low oil quantity, the oil quantity digital readout changes to black text on a white background. The white text **LO** is displayed adjacent to the readout.

For high engine vibration, the vibration digital readout changes to black text on a white background.

Compact Display Format

In compact format, primary and secondary engine indications are combined on the same display. The N_1 and EGT indications are displayed as they are normally (moving pointer/round dial and digital indications). All other indications change to digital readouts only, with the exception that the N_2 digital readout is boxed if a parameter is exceeded. If an amber or red line parameter for a digital indication is exceeded, the digital indication changes color to amber or red (as does the box that appears around the N_2 indication for a red line exceedance). If the N_2 red line is exceeded, the red color of the box around the digital indication can be returned to white (if the exceeded parameter has returned to normal) by pushing the display select panel CANCEL/RECALL switch.

Primary and secondary engine indications are displayed on EICAS in compact format whenever:

- Secondary engine display is automatically selected, and the lower multifunction display is failed, unpowered, or is occupied, or
- Secondary engine display is manually selected to the lower center MFD and the lower MFD is failed, unpowered, or occupied with EICAS.

Electronic Engine Control (EEC)

Each EEC has full authority over engine operation. The EEC uses thrust lever inputs to automatically control forward thrust and reverse thrust. The EEC has two control modes: normal and alternate. In both normal and alternate modes, the EEC uses N_1 RPM as the parameter for setting thrust.

EEC Normal Mode

In the normal mode, the EEC sets thrust by controlling N_1 based on thrust lever position. N_1 is commanded by positioning the thrust levers either automatically with the autothrottles, or manually by the flight crew.

Maximum N_1 represents the maximum rated thrust available from the engine. The EEC continuously computes maximum N_1 .

Maximum rated thrust is available in any phase of flight by moving the thrust levers to the full forward positions.

EEC Alternate Mode

If the required signals are not available to operate in the normal mode, the EEC automatically uses the alternate mode. In the alternate mode, the EEC schedules N_1 as a function of thrust lever position. The alternate mode provides soft and hard levels of control:

- Soft - When the EEC automatically switches an engine to the alternate mode and the EEC mode switch remains in NORMAL, the EEC is in the soft alternate mode (the switch position is NORMAL, the EEC mode is alternate). At a fixed thrust lever position, thrust does not change.
- Hard - When ALTERNATE is manually selected on an EEC mode switch, that engine is switched to the hard alternate mode (the switch position is ALTERNATE, the EEC mode is alternate). Reference and target N_1 , and maximum and commanded N_1 values are displayed on the N_1 indication during the hard alternate mode. Thrust may change to set the commanded N_1 when ALTERNATE is manually selected.

For the normal, soft alternate, and hard alternate modes, actual, command, reference/target, maximum, and red line N_1 information is displayed.

Automatic reversion or manual selection to the alternate mode is indicated by the EICAS advisory message **ENG EEC MODE (L, R)** and illumination of the EEC alternate light on the associated EEC mode switch. Selecting the alternate mode on both engines eliminates thrust lever stagger at equal thrust settings, or asymmetric thrust when the thrust levers are operated together.

The autothrottles remain engaged whenever the EEC automatically switches to the alternate mode. The alternate mode N_1 reference/target values are computed by the FMC.

Note: Autothrottles remain engaged in the soft or hard alternate mode.

The alternate mode schedule (N_1 schedule) provides equal or greater thrust than the normal mode for the same thrust lever position.

Thrust protection is not provided in the alternate mode and maximum rated thrust is reached at a thrust lever position less than full forward. As a result, thrust overboost can occur at full forward thrust lever positions. The EICAS caution message **ENG LIMIT PROT (L, R)** is displayed if the thrust lever position commands an N_1 greater than the maximum rated thrust (maximum N_1). N_1 and N_2 red line protection is still available in the alternate control mode.

Overspeed Protection

The EEC also provides N_1 and N_2 red line overspeed protection. If N_1 or N_2 approaches overspeed, the EEC commands reduced fuel flow. The EICAS advisory message **ENG RPM LIMITED (L or R)** is provided when overspeed protection is provided.

EEC Idle Selection

The EEC selects minimum idle or approach idle automatically. Minimum idle is a lower thrust than approach idle. Approach idle is selected in flight if:

- Engine anti-ice is ON
- The flaps are commanded to 25 or greater
- One hydraulic system air-driven demand pump is inoperative, and the flaps are out of the UP position, or
- The opposite engine bleed air valve is closed.

Approach idle decreases acceleration time for go-around. Approach idle is maintained until after touchdown, when minimum idle is selected.

Engine Start and Ignition System

The engines can be started using the autostart system or manually. Autostart is the normal starting mode. Selecting OFF on the AUTOSTART switch disables autostart and allows manual, pilot-monitored, starting.

Bleed air powers the starter motor, which is connected to the N₂ rotor. The starter air source is normally the APU, but air from ground carts or another running engine can be used.

The START/IGNITION selectors control the starter air valves and provide continuous ignition capability. Ignition and fuel flow are controlled through the FUEL CONTROL switches.

At approximately idle N₂ RPM, the EEC commands starter cutout, and the START/IGNITION selector moves to the NORM position.

A maximum start limit line (red) is displayed on the EGT indication when the FUEL CONTROL switch is moved to CUTOFF or engine N₂ RPM is below idle.

It remains displayed after the FUEL CONTROL switch is moved to RUN until the engine is stabilized at idle. The EGT indication changes color to red if the EGT start limit is reached during starting.

Autostart

Autostart allows the EEC to control fuel and ignition and automatically abort the start for certain malfunctions. With the AUTOSTART switch ON, the autostart sequence is initiated by rotating the START/IGNITION selector to START and moving the FUEL CONTROL switch to RUN.

The START/IGNITION selector opens the starter air valve to begin dry motoring the engine. Moving the FUEL CONTROL switch to RUN opens the spar fuel valve, but not the engine fuel valve. The proper sequencing of fuel and ignition is controlled by the autostart system. With the FUEL CONTROL switch positioned to RUN, the EEC opens engine fuel valve and energizes the ignitor(s) at the appropriate N_2 RPM.

During autostart, the EEC monitors EGT, N_2 RPM, and other engine parameters until the engine reaches idle. During ground start, the autostart system monitors engine parameters and will abort the start for any of the following malfunctions:

- Hot start
- Hung start
- No EGT rise
- Compressor stall
- Starter shaft failure
- No N_1 rotation
- Insufficient air pressure for starter operation
- Start time exceeds the starter duty cycle timer.

Note: The autostart system does not monitor oil pressure and temperature.

If one of the above malfunctions is detected, the EEC turns off fuel and ignition and motors the engine for 6 or 30 seconds (depending on the detected condition) before making a second start attempt. The second attempt uses both ignitors.

Note: On the ground, autostart does not attempt a second start if there is no N_1 rotation, insufficient air pressure, the starter shaft fails, or the start time exceeds the starter duty cycle.

If the second start attempt fails, a third start attempt is made. On the ground, if the third attempt fails, the EEC aborts the autostart. Fuel and ignition are shut off, and the engine is motored to clear residual fuel. The starter air valve then closes and the START/IGNITION selector returns to the NORM position. The EICAS caution message **ENG AUTOSTART (L or R)** is displayed.

Note: For in-flight starts, the autostart system discontinues the start temporarily only if a preset EGT between the start and takeoff EGT is reached, or a hung start is detected. Autostart takes corrective action if some start problems are detected, but does not abort the start.

Whenever the AUTOSTART switch is selected OFF, the EICAS advisory message **ENG AUTOSTART OFF** is displayed and the AUTOSTART switch **OFF** light illuminates.

Manual Start

The AUTOSTART switch must be OFF to accomplish a manual start. The start is accomplished in accordance with the ENG MANUAL START procedure (refer to Section 2). Ignition and fuel are provided as soon as the FUEL CONTROL switch is positioned to RUN. The **ENG AUTOSTART** EICAS message will be displayed if the FUEL CONTROL switch is positioned to RUN before the RPM specified in the ENG MANUAL START procedure. The start must be monitored until the engine stabilizes at idle.

In-Flight Start

In-flight start envelope information is displayed on the EICAS display when an engine is not running in flight (N_2 RPM below idle RPM) or when an engine is shut down in flight and the respective engine fire switch is not pulled. The In-flight start envelope indicates the airspeed range necessary to ensure an in-flight start at the current flight level. If the current flight level is above the maximum start altitude, the maximum start altitude and respective airspeed range are displayed.

Secondary engine indications are displayed automatically when a FUEL CONTROL switch is moved to CUTOFF in flight or if N_2 RPM goes below idle RPM while in flight. A crossbleed start indication is displayed next to the N_2 indication if airspeed is below that recommended for a windmilling start.

Refer to Engine In-Flight Start, Section 2 for the In-flight Start procedure.

For In-flight starts, autostart makes continuous start attempts until the engine either starts or the pilot aborts the start attempt by positioning the FUEL CONTROL switch to CUTOFF (and positioning the start switch to NORM if it was a starter assisted attempt).

Engine Ignition

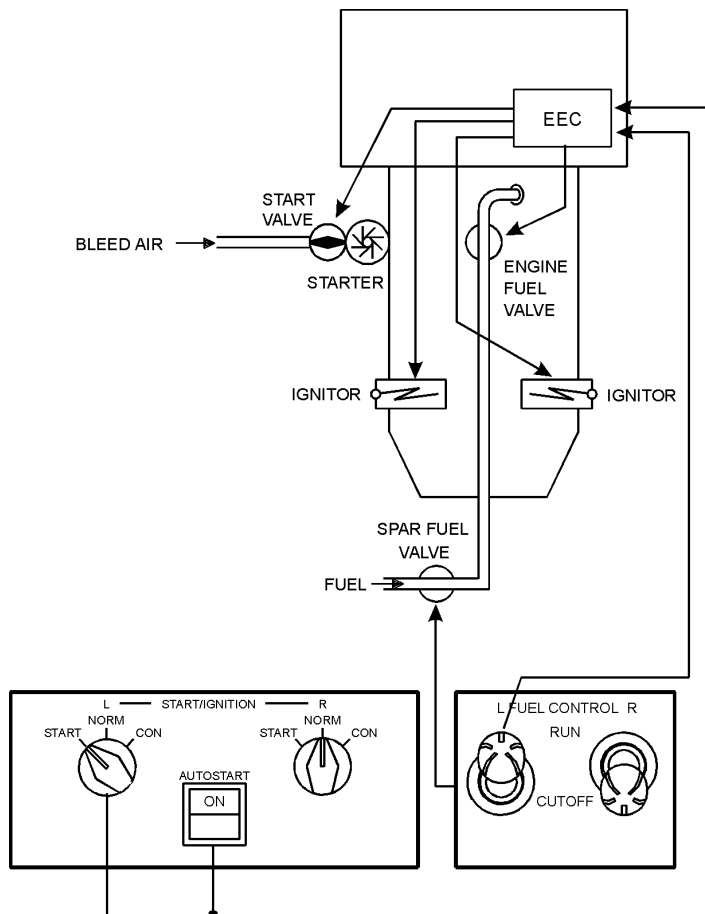
Each engine has two ignitors. The EEC automatically selects the appropriate ignitor(s). The EEC alternates ignitors for successive engine ground starts. Dual ignitors are always used for In-flight starts.

Main AC power is the normal power source for ignition. Standby AC power provides a backup source.

Both ignitors operate continuously only when the respective FUEL CONTROL switch is in RUN and the PS3 compressor discharge pressure drops below a preset level. The ignitors are turned off when the FUEL CONTROL switch is placed to CUTOFF.

Auto-Relight

An auto-relight capability is provided for flameout protection. Whenever the EEC detects an engine flameout, both ignitors are activated. A flameout is detected when a rapid decrease in N_2 occurs, or N_2 is less than idle RPM.



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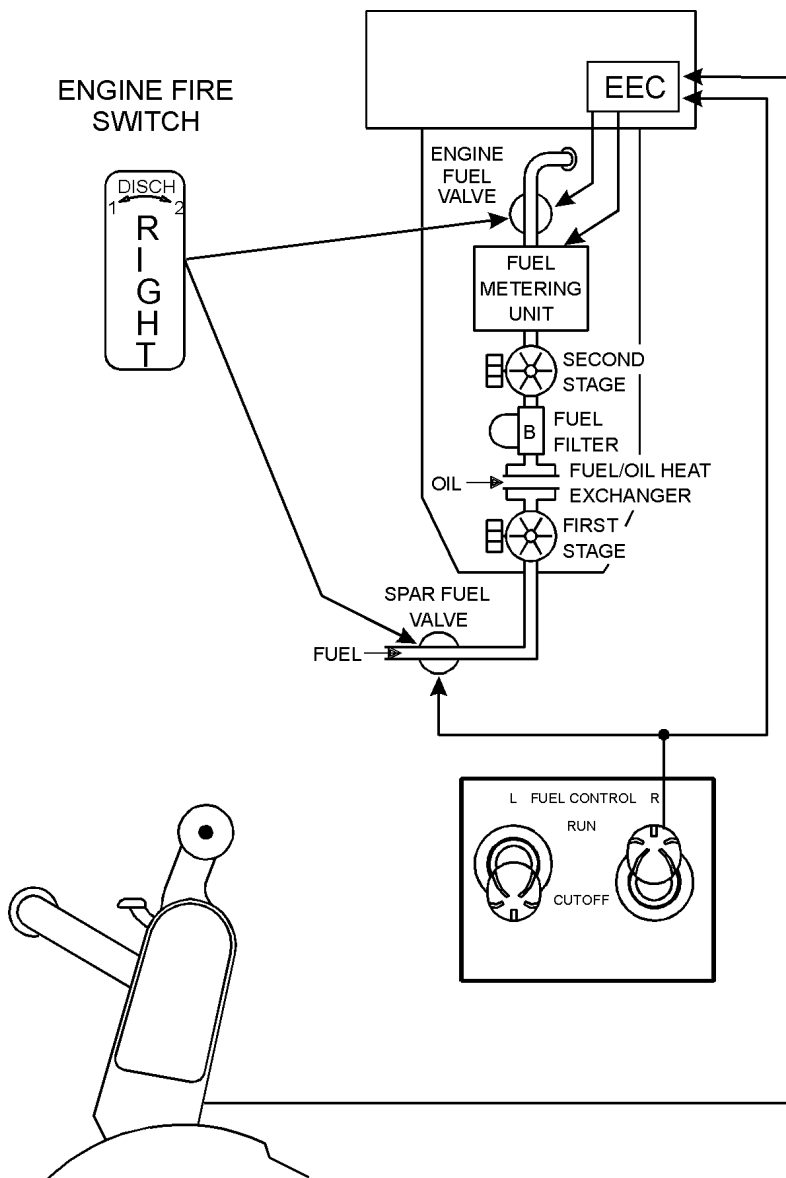
ENGINE START AND IGNITION SYSTEM SCHEMATIC

Engine Fuel System

Fuel is supplied by fuel pumps located in the fuel tanks. The fuel flows through a spar fuel valve located in the main tank. It then passes through the first stage engine fuel pump where additional pressure is added. It flows through a fuel/oil heat exchanger where it is preheated. A fuel filter removes contaminants. The second stage of the engine fuel pump adds more pressure before the fuel reaches the fuel metering unit. The fuel metering unit adjusts fuel flow to meet thrust requirements. The fuel then flows through the engine fuel valve into the engine.

The spar and engine fuel valves allow fuel flow to the engine when both valves are open. The valves open when the engine fire switch is IN and the FUEL CONTROL switch is in RUN. Both valves close when either the FUEL CONTROL switch is in CUTOFF or the engine fire switch is OUT.

Fuel flow is measured after passing through the engine fuel valve. Fuel flow is displayed on the secondary engine display. Fuel flow information is also provided to the FMS.



7771202

ENGINE FUEL SYSTEM SCHEMATIC

Engine Oil System

The oil system provides pressurized oil to lubricate and cool the engine main bearings, gears and accessory drives. The oil system also provides automatic fuel heating for fuel system icing protection.

Oil is pressurized by an engine driven oil pump. The oil pressure varies directly as a function of N_2 (core) rotation speed, aircraft altitude, engine position (left wing or right wing), oil quantity and oil viscosity. The engine oil pump (and associated scavenge pump) is driven by the N_2 rotor through the accessory gearbox. At any given set of altitude and temperature conditions, the faster the N_2 rpm, the higher the oil pressure output.

The oil pressure varies inversely as a function of altitude. It is not uncommon to see a 20 psi drop in oil pressure when climbing from 20,000 feet to 43,000 feet.

From the pump, the oil flows through the oil filter. The oil flows through the fuel/oil heat exchangers and then through the backup generator oil/oil heat exchanger, and is then delivered to the engine main bearings, gears, and accessory drives. A scavenge pump returns the oil to the reservoir.

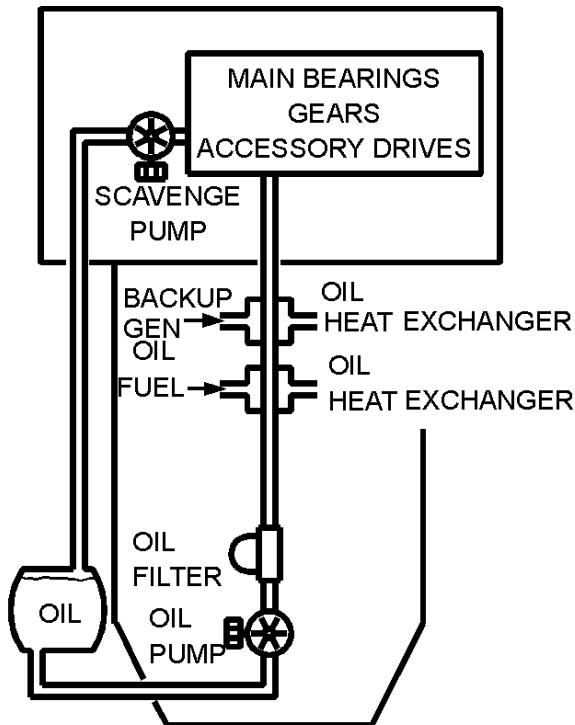
The physical difference in tank position also effects the quantity sensed in each engine. The physical volume of the tank is 34.4 quarts of which 4 – 5 quarts are not reflected in the oil quantity indicator. Additionally, oil that is pooled in the engine sump is not shown on the quantity indicator as it is below the quantity sensor. Typically, if the oil has been serviced prior to engine start, the left engine will have 24 quarts and the right engine will have 23 quarts.

During the start sequence, the oil quantity may drop 4 – 6 quarts. This oil “gulping” is normal. The quantity should return to normal within 3 to 5 minutes. If the oil quantity does not read at least 18 quarts after the engines are stabilized, the system should be investigated. Normal oil consumption rates are typically .4 to .6 quarts an hour.

There is no minimum oil quantity limit (no amber or red line limit); however, a low oil quantity causes automatic display of the secondary engine display and reverses the display indication to show black numbers on a white background. There are no operating limitations for the engine oil quantity; therefore, there are no flight crew procedures based solely on a response to low oil quantity.

Note: If the scavenge pump is slow in returning oil from the 3 different sumps, a low oil quantity (from the tank sensor) will be observed on the EICAS oil quantity indicator. The “gulped oil” will normally return to the tank during descent or when the scavenge pump is able to keep pace with the pressure pump output.

Oil pressure, temperature, and quantity are displayed on the secondary engine display. Oil pressure and oil temperature are measured prior to entering the engine.



7771203

ENGINE OIL SYSTEM SCHEMATIC

Thrust Reverser System

Each engine has an hydraulically actuated fan air thrust reverser. Reverse thrust is available only on the ground.

The reverse thrust levers can be raised only when the forward thrust levers are in the idle position. When the reverse thrust levers are raised, the EEC opens the reverser isolation valve. The EEC inhibits reverser isolation valve actuation and reverser deployment unless the airplane is on the ground with the engine running. The EECs also control thrust limits during reverser operation.

When the reverse thrust levers are pulled aft to the interlock position:

- The autothrottle disengages
- The auto speedbrakes deploy.

When the reverser system is activated:

- The reverser translating sleeves hydraulically move aft
- The fan flow blocker doors rotate into place to direct fan air through stationary cascade guide vanes
- The reverser indication (**REV**) is displayed above each digital N_1 indication (**REV** is displayed in amber when the reverser is in transit).

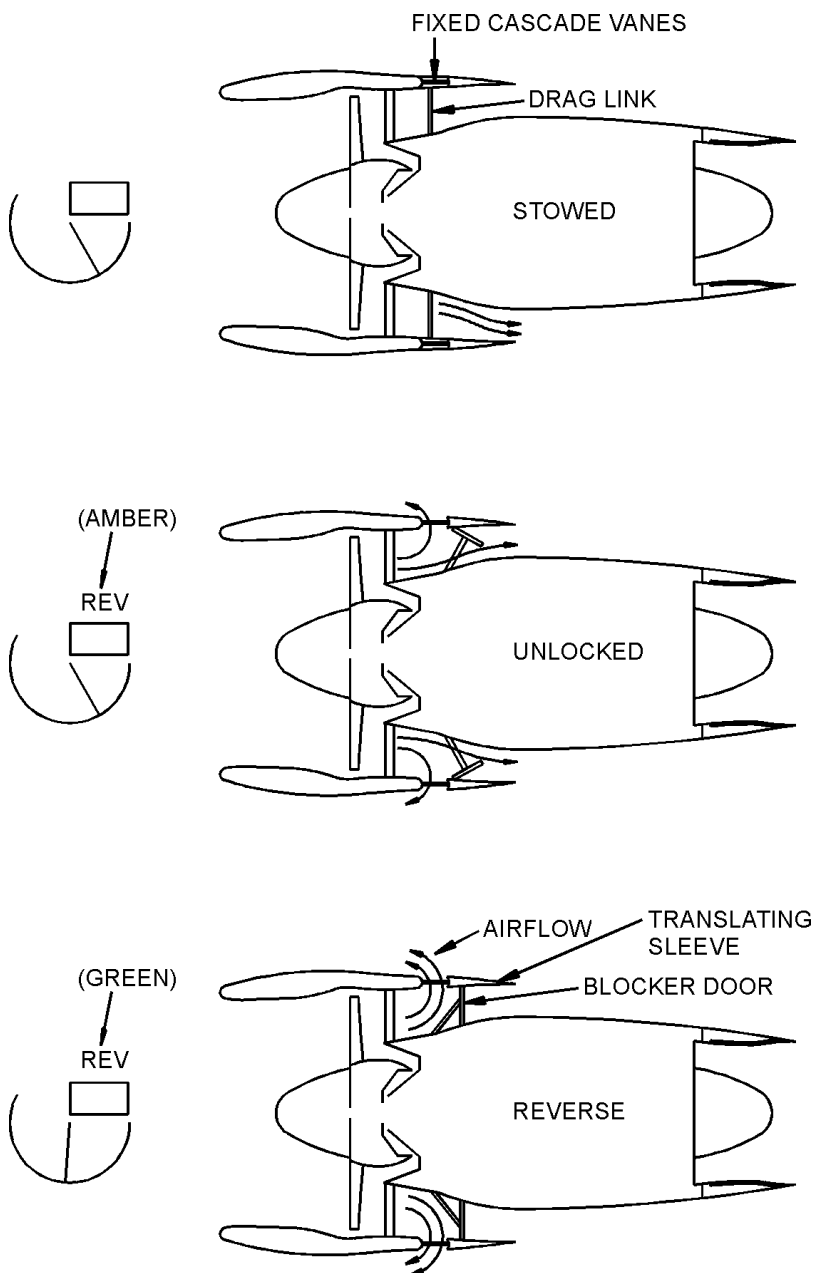
When the interlock releases:

- The reverse thrust levers can be raised to the maximum reverse thrust position
- The **REV** indication changes to green when the reverser is fully deployed.

Pushing the reverse thrust levers to the full down position retracts the reversers to the stowed and locked position. The thrust levers cannot be moved forward until the reverse thrust levers are fully down.

The EICAS advisory message **ENG REV LIMITED (L or R)** is displayed if the reverser cannot deploy when commanded, or can deploy only with reverse thrust limited to idle. Not all conditions limiting or preventing reverse thrust can be detected before reverse thrust selection. For these conditions, the reverse thrust levers cannot be moved beyond the interlock position.

The EICAS advisory message **ENG REVERSER (L or R)** is displayed on the ground to indicate a reverser system fault.



7771204

THRUST REVERSER SCHEMATIC

Airborne Vibration Monitoring System

The airborne vibration monitoring system monitors engine vibration levels. The vibration indications are displayed on the secondary engine display. The vibration source indication is also displayed. If the vibration monitoring system cannot determine the source (N_1 or N_2), broadband (BB) is displayed for the affected engine. Broadband vibration is the average vibration detected.

The airborne vibration monitoring system is primarily intended for engine condition monitoring, but it is also a useful tool for isolating and determining corrective action for engine anomalies. There is no certified vibration limit, but when a high vibration level is reached, the secondary engine parameters are automatically displayed. Since there are no operating limitations for the airborne vibration monitoring system, there are no specific flight crew actions (or procedures) based solely on vibration indication. High N_1 vibration indication would most likely be accompanied by tactile vibration. This is not the case with high N_2 vibration indication. Both N_1 and N_2 high vibrations may be accompanied by anomalies in other engine parameters and will usually respond to thrust lever adjustment.

Certain engine malfunctions can result in airframe vibrations from the windmilling engine. As the airplane transitions from cruise to landing, there can be multiple, narrow regions of altitudes and airspeeds where the vibration level can become severe. In general, airframe vibrations can best be reduced by descending and reducing airspeed. However, if after descending and reducing airspeed, the existing vibration level is unacceptable, and if it is impractical to further reduce airspeed, the vibration level may be reduced to a previous, lower level by a slight increase in airspeed.

Engine Failure Alert System

The airplane has an engine failure alert system. The system alerts the flight crew whenever actual engine performance is in disagreement with commanded engine performance.

Engine failure alert is a time critical warning during takeoff and a caution level alert for all other phases of flight.

The time critical warning consists of:

- An aural alert - Engine Fail (one time)
- Illumination of the **MASTER WARNING** lights, and
- The PFD time critical warning message **ENG FAIL**.

The caution alert consists of:

- The caution beeper
- Illumination of the **MASTER CAUTION** lights, and
- An EICAS caution message **ENG FAIL (L or R)** or **ENG THRUST (L or R)**.

The time critical warning is annunciated when the engine produces less than commanded thrust and the airplane is above 65 knots to slightly below V_1 .

The EICAS caution message **ENG FAIL (L or R)** is displayed whenever an engine unexpectedly decelerates below idle speed. The message remains displayed until the engine recovers or the fuel control switch is moved to CUTOFF.

The EICAS caution message **ENG THRUST (L or R)** is displayed if:

- A significant difference between actual and commanded thrust is detected
- The actual thrust is not increasing towards the commanded thrust, and airspeed is V_1 or higher.

APU

Introduction

The auxiliary power unit (APU) is a self-contained gas turbine engine located in the airplane tail cone.

The APU can be started and operated to the airplane maximum certified altitude.

The APU supplies bleed air and electrical power. Electrical power has priority over bleed air. Electrical power is available throughout the airplane operating envelope. Bleed air is available at or below 22,000 feet.

Refer to the following chapters for additional information:

- Section 6.2, Air Systems, for a description of APU bleed air operation
- Section 6.6, Electrical, for a description of APU electrical operation
- Section 6.8, Fire Protection, for a description of the APU fire protection system
- Section 6.12, Fuel, for a description of the APU fuel system.

APU Start

The APU is started either by an electric start motor or an air turbine starter.

The electric starter is powered by the APU battery. The main airplane battery powers the inlet door, fuel valve, and fire detection system.

The air turbine starter uses engine bleed air or ground cart air to start the APU.

Starter selection is automatic. The air turbine starter has priority over the electric start motor when there is sufficient bleed air duct pressure.

Rotating the APU selector to **START** begins the automatic start sequence.

APU fuel is supplied from the left fuel manifold by any operating AC fuel pump or the DC fuel pump. With AC power available and the APU selector in the **ON** position, the left forward fuel pump operates automatically.

If AC power is not available or no AC pump pressurizes the left fuel manifold, the DC pump in the left main tank provides APU fuel. On the ground, the APU can be started with no pumps operating.

When the APU air inlet door reaches the full open position the starter engages. After the APU reaches the proper speed, ignition and fuel are provided. When the APU reaches approximately 50 percent, the starter disengages and ignition is turned off.

If the start fails, the APU shuts down automatically. The EICAS message **APU SHUTDOWN** is displayed.

APU Automatic Start

In flight, if both AC transfer busses lose power, the APU automatically starts, regardless of APU selector position. The APU can be shut down by positioning the selector to ON, then OFF.

APU Run

The EICAS memo message **APU RUNNING** is displayed when the APU is operating normally.

APU Shutdown

Rotating the APU selector to OFF begins the shutdown cycle by closing the APU bleed air valve. The APU continues running for a cool down period. The EICAS memo message **APU COOLDOWN** is displayed during the cooldown period. When the cool down period finishes, the APU shuts down.

APU Operating Modes

The APU has attended and unattended operating modes. The attended mode operates when either engine is running or starting, or when the airplane is in flight. The unattended mode operates at all other times on the ground.

APU Attended Mode

In the attended mode, any of the following faults cause the APU to shut down immediately:

- APU fire/inlet overtemperature
- Overspeed/loss of overspeed protection
- APU controller failure
- Speed droop.

There is no cool down period. The EICAS advisory message, **APU SHUTDOWN**, displays.

For the following faults, the APU continues to operate and the EICAS message **APU LIMIT** displays:

- High EGT
- High oil temperature
- Low oil pressure.

There is no cooldown period when the APU is shut down after the **APU LIMIT** message is displayed.

APU Unattended Mode

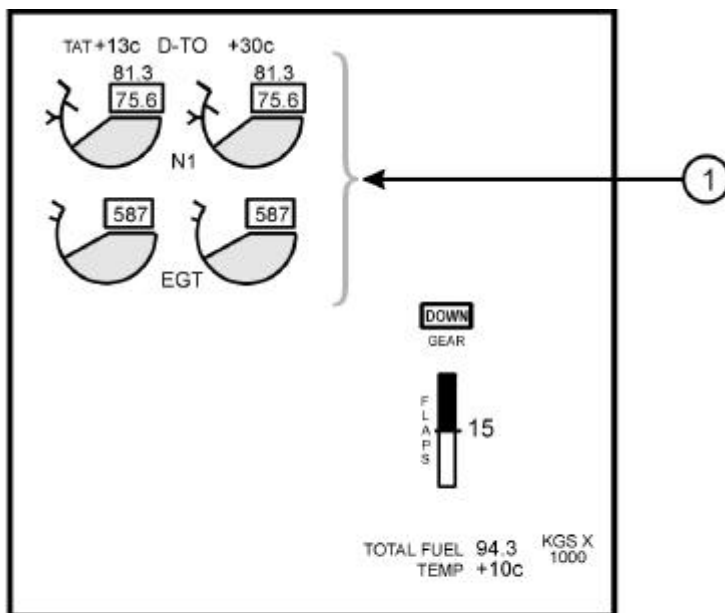
In the unattended mode, any of the following faults cause the APU to shutdown immediately:

- APU fire/inlet overtemperature
- Overspeed/loss of overspeed protection
- APU controller failure
- Speed droop
- High EGT
- High oil temperature
- Low oil pressure
- Generator oil filter approaching bypass
- Intake door failure
- No combustion on start
- No acceleration on start.

There is no cool down period.

CONTROLS AND INDICATORS

EICAS DISPLAY



UPPER CENTER DISPLAY

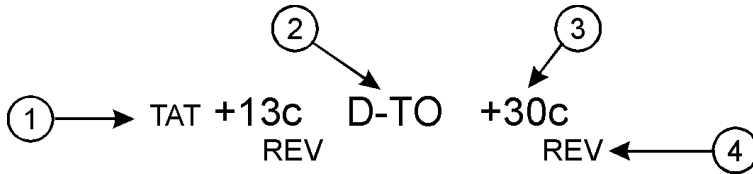
7771205

① Primary Engine Indications

Displayed full time on the EICAS display:

- N₁
- EGT.

MODE INDICATIONS



EICAS DISPLAY (TOP)

7771206

- ① Total Air Temperature (TAT)

Displayed (white) - TAT (degrees C).

- ② Thrust Reference Mode

Displayed (green) - Selected FMS thrust reference mode:

- TO - Maximum rated takeoff thrust
- D-TO - Assumed temperature derated takeoff thrust
- CLB - Maximum rated climb thrust
- CLB 1 - Derate one climb thrust
- CLB 2 - Derate two climb thrust
- CON - Maximum rated continuous thrust
- CRZ - Maximum rated cruise thrust
- G/A - Maximum go-around thrust.

③ Assumed Temperature

Displayed (green) - Selected assumed temperature (degrees C) for reduced thrust takeoff.

④ Thrust Reverser Indication

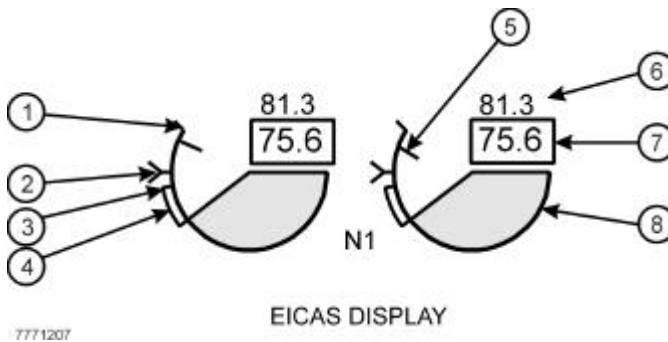
Displayed **REV** (amber) - Reverser in transit.

Displayed **REV** (green) - Reverser fully deployed.

N₁ INDICATIONS (ALL MODES)

Note: When reverse thrust is activated, the following indications are not displayed:

- Maximum N₁ line
- Commanded N₁
- Reference/target N₁
- Reference N₁.



① N₁ Red Line

Displayed (red) - N₁ RPM operating limit.

② Reference/Target N₁

Displayed (green) - Reference N₁ limit.

Displayed (magenta) - Target FMC commanded N₁ when VNAV is engaged and:

- The autothrottle is engaged in THR or THR REF mode, or
- The autothrottle is not engaged.

③ Commanded N₁

Displayed (white).

④ Commanded N₁ Sector

Displays momentary difference between engine N₁ and N₁ commanded by thrust lever position.

⑤ Maximum N_1 Line

Displayed (amber).

⑥ Reference N_1

Displayed (digital, green).

⑦ N_1

Digital N_1 % RPM, displayed:

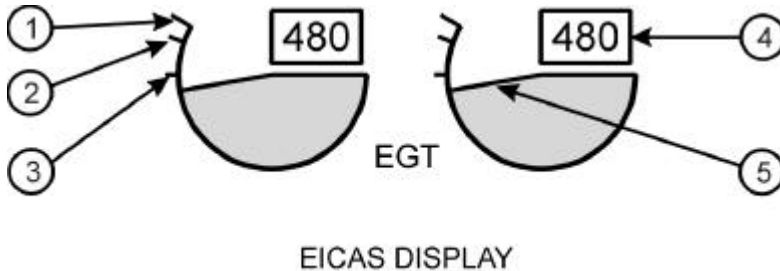
- (White) - Normal operating range
- (Red) - Operating limit reached.

⑧ N_1 Indication

N_1 RPM, displayed:

- (White) - Normal operating range
- (Red) - Operating limit reached.

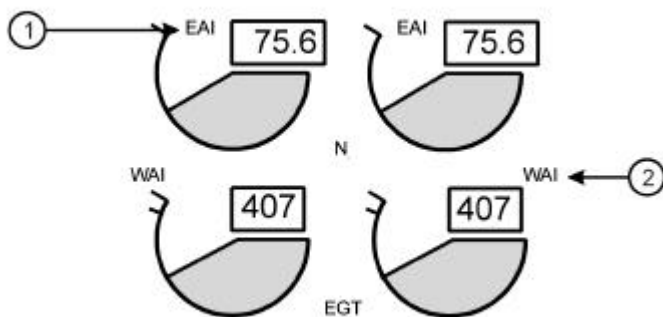
EGT INDICATIONS



7771208

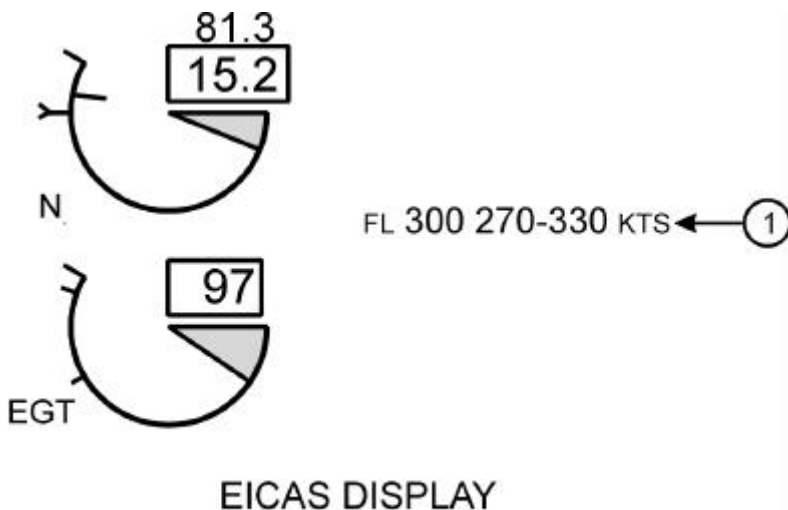
- ① EGT Red Line
Displayed (red) - Maximum takeoff EGT limit.
- ② EGT Amber Band
Displayed (amber) - Maximum continuous EGT limit.
- ③ EGT Start Limit Line
Displayed (red):
 - With the FUEL CONTROL switch in CUTOFF, or
 - With the N₂ RPM below idle.
- ④ EGT
EGT (degrees C) displayed:
 - (White) - Normal operating range
 - (Amber) - Maximum continuous limit reached
 - (Red) - Maximum start or takeoff limit reached.
- ⑤ EGT Indication
Displayed:
 - (White) - Normal operating range
 - (Amber) - Maximum continuous limit reached
 - (Red) - Maximum start or takeoff limit reached.

ANTI-ICE INDICATIONS



- ① Engine Anti-ice Indication
Displayed (green) - Engine anti-ice is on.
- ② Wing Anti-Ice Indication
Displayed (green) - Wing anti-ice is on.

IN-FLIGHT START ENVELOPE

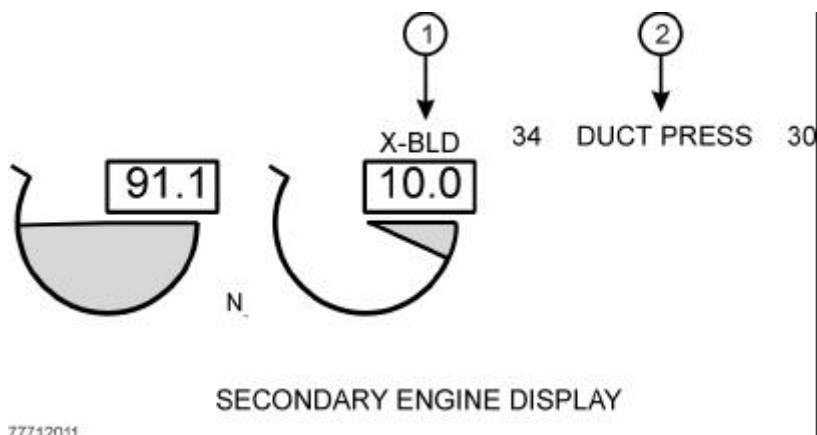


77712010

① In-Flight Start Envelope

Displayed (magenta) - Airspeed range for an in-flight start at the current flight level or maximum flight level (whichever is less) when the respective engine fire switch is in and:

- A FUEL CONTROL switch is in CUTOFF, or
- Engine N₂ RPM is below idle.

CROSSBLEED START INDICATIONS**① CROSSBLEED START Indication**

Indicates crossbleed air is recommended for an in-flight start.

Displayed (magenta):

- The in-flight start envelope is displayed, and
- Airspeed is lower than that for a windmilling start.

② DUCT PRESSURE

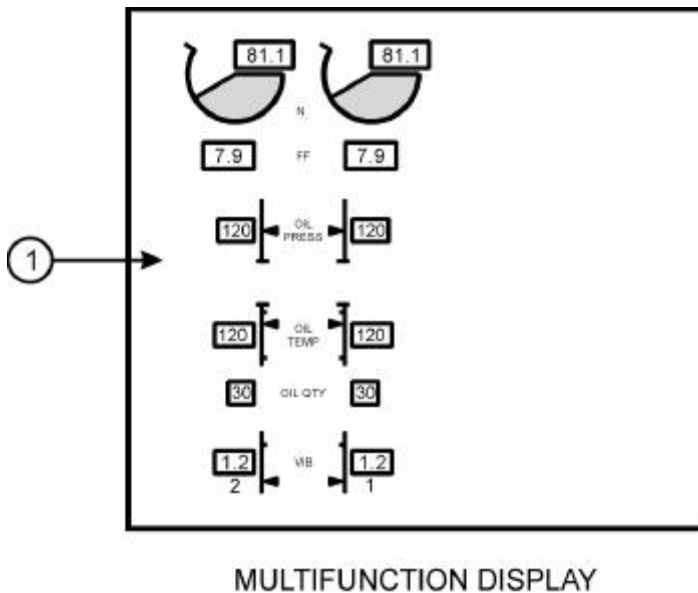
Displayed (white numbers) - Pressure in the left and right bleed air ducts in psi when the respective engine fire switch is in and:

- A FUEL CONTROL switch is in CUTOFF, and
- Engine N₂ RPM is below idle.

SECONDARY ENGINE INDICATIONS

See Section 6.10, Flight Instruments, Displays, for display selection of Secondary Engine indications.

Secondary Engine Display



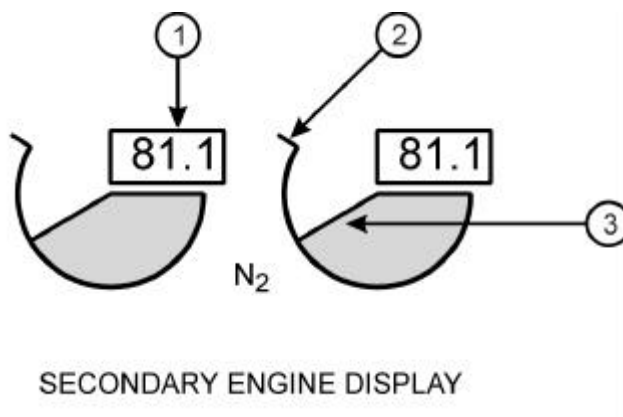
77712012

① Secondary Engine Display

Displays:

- N₂ RPM
- Fuel Flow (FF)
- Oil pressure
- Oil temperature
- Oil quantity
- Vibration.

N₂ Indications



77712013

① N₂

N₂ RPM (%), displayed:

- (White) - Normal operating range
- (Red) - Operating limit reached.

② N₂ Red Line

N₂ RPM operating limit, displayed (red).

③ N₂ Indication

N₂ RPM, displayed:

- (White) - Normal operating range
- (Red) - Operating limit reached.

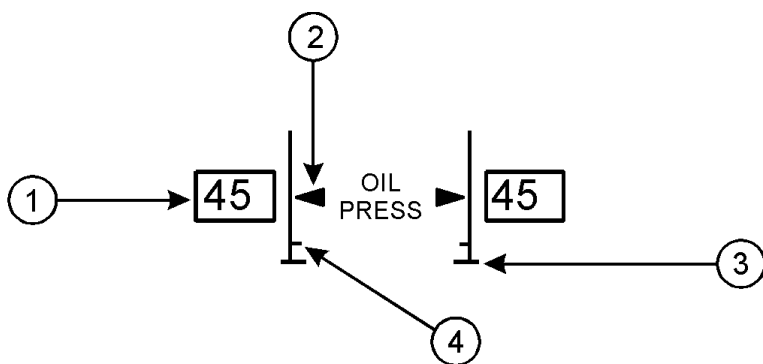
Fuel Flow Indications



SECONDARY ENGINE DISPLAY

77712014

- ① Fuel Flow
Displayed (White) - Fuel flow to the engine (pounds per hour x 1000).

Oil Pressure Indications**SECONDARY ENGINE DISPLAY**

77712015

① Oil Pressure

Engine oil pressure (psi), displayed:

- (White) - Normal operating range
- (Amber) - Caution range reached
- (Red) - Operating limit reached.

② Oil Pressure Pointer

Engine oil pressure, displayed:

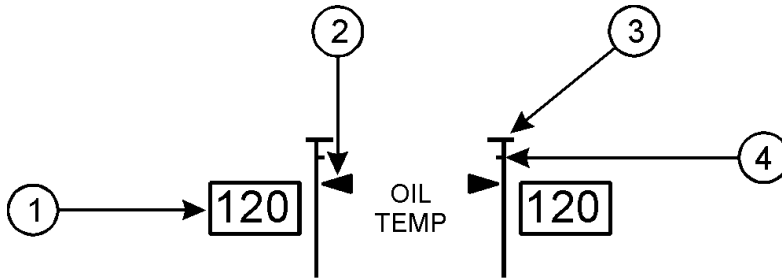
- (White) - Normal operating range
- (Amber) - Caution range reached
- (Red) - Operating limit reached.

③ Oil Pressure Red Line

Displayed (red) - Oil pressure operating limit.

④ Oil Pressure Amber Band

Displayed (amber) - Oil pressure caution range.

Oil Temperature Indications**SECONDARY ENGINE DISPLAY**

77712016

① Oil Temperature

Engine oil temperature (°C), displayed:

- (White) - Normal operating range
- (Amber) - Caution range reached
- (Red) - Operating limit reached.

② Oil Temperature Pointer

Engine oil temperature, displayed:

- (White) - Normal operating range
- (Amber) - Caution range reached
- (Red) - Operating limit reached.

③ Oil Temperature Red Line

Displayed (red) - Oil temperature operating limit.

④ Oil Temperature Amber Band

Displayed (amber) - Oil temperature caution range.

Oil Quantity Indications**SECONDARY ENGINE DISPLAY**

77712017

① Oil Quantity

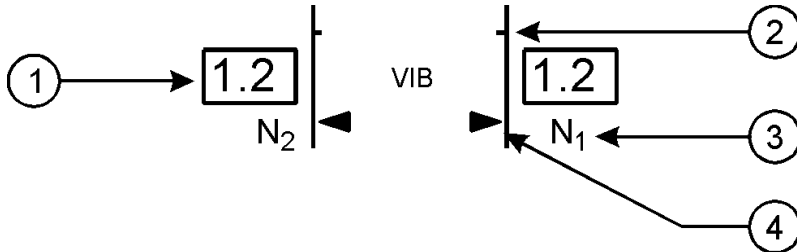
Usable oil quantity (quarts).

Displayed:

- (White) - Normal quantity
- (Reverses the display to show black numbers on white background) - Low quantity.

Note: LO - Displayed (white) when quantity is low.

Engine Vibration Indications



SECONDARY ENGINE DISPLAY

77712018

① Engine Vibration

Engine vibration, displayed:

- (White) - Normal operating range
- (Black numbers, white background) - High vibration.

② Engine Vibration High Band

Displayed (white) - Vibration level at which automatic display of secondary engine indications occurs.

③ Vibration Source

Identifies the vibration source being displayed.

Displayed (white) - Vibration source with the highest vibration:

- N_1 rotor vibration
- N_2 rotor vibration.

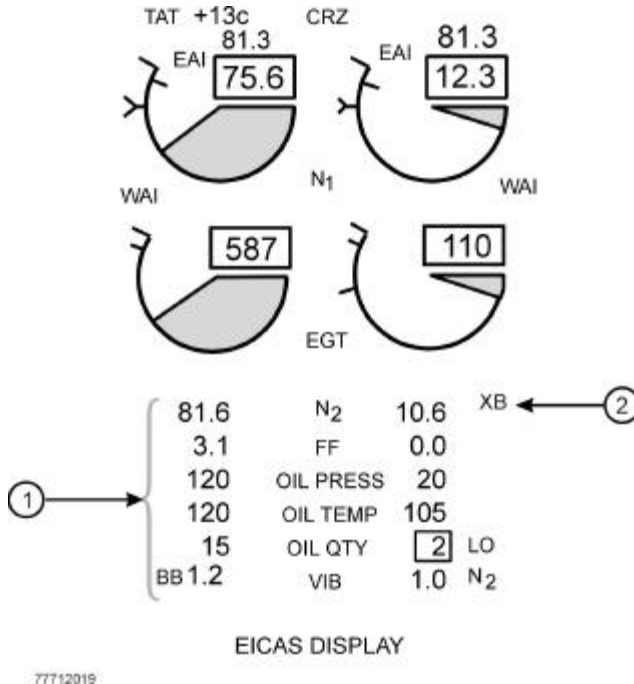
If the vibration source BB (broad band vibration) is displayed, the source is unknown and average vibration is displayed.

④ Engine Vibration Pointer

Displayed (white) - Engine vibration.

Compact Engine Indications

See Section 6.10, Flight Instruments, Displays, for manual and automatic display switching operation.



① Compact Engine Indications

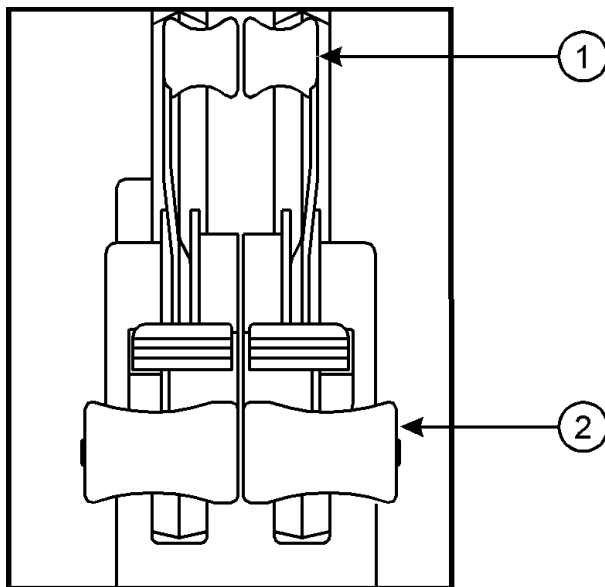
The following changes to EICAS and the normal secondary engine display occur:

- N₂ changes from round dial displays to a digital display. An amber or red box frames the digital display if limits are exceeded.
- FF, OIL PRESS, OIL TEMP are displayed as digital readouts only. The digital displays turn amber or red if limits are exceeded.
- OIL QTY and VIB are displayed as digital readouts only. Low oil quantity and high vibrations are displayed the same as in the normal format.

② Crossbleed start indication

Displayed (magenta).

INTENTIONALLY LEFT BLANK

ENGINE CONTROLS**Thrust Levers****CONTROL STAND**

77712020

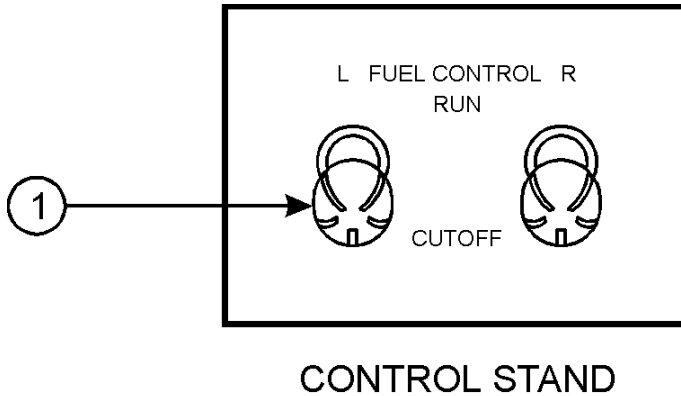
① Reverse Thrust Levers

- Control engine reverse thrust.
- Reverse thrust can only be selected when the forward thrust levers are closed.
- Actuates automatic speedbrakes (refer to Section 6.9, Flight Controls).

② Forward Thrust Levers

- Controls engine forward thrust.
- The thrust levers can only be advanced if the reverse thrust levers are down.

Fuel Control Switches



77712021

① FUEL CONTROL Switch

RUN (AUTOSTART ON) -

- Opens the spar fuel valve
- Arms the engine fuel valve (the EEC opens the valve when required)
- Arms the selected ignitors(s) (the EEC turns the ignitors on when required).

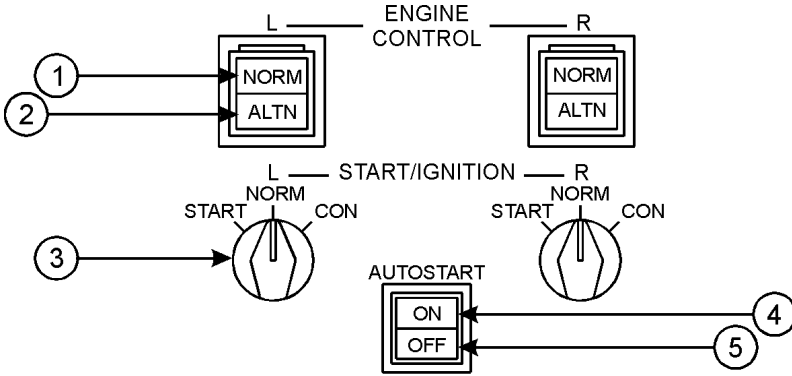
RUN (AUTOSTART OFF) -

- Opens the spar fuel valve
- Opens the engine fuel valve
- Turns ignitors on.

CUTOFF -

- Closes the fuel valves
- Removes ignitor power
- Unlocks the engine fire switch.

Engine Control Panel



OVERHEAD PANEL

77712022

① Electronic Engine Control (EEC) Mode Switch

NORM -

- Selects the normal engine control mode for engine control
- The EEC sets thrust using N_1 RPM as the controlling parameter.

Off (ALTN visible) -

- Selects the alternate engine control mode for engine control
- Thrust is set using N_1 RPM as the controlling parameter.

② Electronic Engine Control (EEC) Alternate (ALTN) Light

Illuminated (amber) - The alternate engine control mode is either automatically or manually selected.

③ START/IGNITION Selector

START -

- Initiates engine start by opening the start valve
- Releases to NORM at start valve cutout.

NORM -

- The start valve closes
- Automatic ignition is provided for both ignitors (if the FUEL CONTROL switch is in RUN).

CON – This position has no function on CAL GE – equipped aircraft. (Both ignitors operate continuously only when the respective FUEL CONTROL switch is in RUN and the PS3 compressor discharge pressure drops below a preset level, regardless of switch position.)

④ AUTOSTART Switch

ON - Arms the autostart system.

OFF -

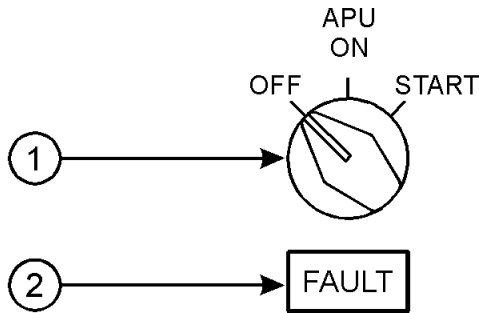
- The autostart system is disabled
- The start is manually controlled.

⑤ AUTOSTART OFF Light

Illuminated (amber) - The AUTOSTART switch is OFF.

AUXILIARY POWER UNIT (APU)

APU Controls



OVERHEAD PANEL

77712023

① APU Selector

OFF -

- Closes the APU bleed air isolation valve
- Initiates normal shutdown
- Resets auto shutdown fault logic.

ON - (APU operating position)

- Opens the APU fuel valve and inlet door
- Activates AC or DC fuel pump
- Powers the APU controller.

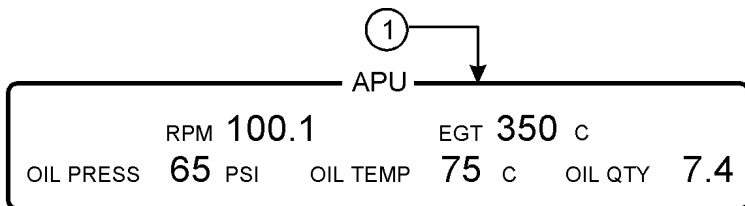
START - (momentary position, spring-loaded to ON) - Initiates automatic start sequence.

② APU FAULT Light

Illuminated (amber):

- APU fault and/or fire is detected
- APU shutdown due to fault and/or fire
- Momentarily during APU controller self-test.

APU Indications



MFD STATUS DISPLAY

77712024

① APU Status Display

- **RPM** - APU rotation speed in percent RPM.
- **EGT** - APU exhaust gas temperature.
- **OIL PRESS** - APU oil pressure in PSI.
- **OIL TEMP** - APU oil temperature.
- **OIL QTY** - APU oil quantity (quarts).

ENGINES, APU EICAS MESSAGES

The following EICAS messages can be displayed.

APU

Message	Level	Aural	Condition
APU COOLDOWN	Memo		APU is in cool down mode.
APU LIMIT	Caution	Beeper	APU operation has exceeded a limit.
APU RUNNING	Memo		APU running, and not in cool down mode.
APU SHUTDOWN	Advisory		APU has automatically shut down.

Engine

Control

Message	Level	Aural	Condition
ENG ANTI-ICE AIR L, R	Advisory		Engine anti-ice capability is degraded.
ENG CONTROL L, R	Advisory		Fault is detected in the affected engine control system.
ENG EEC MODE L, R	Advisory		Control for the affected engine is operating in alternate mode.
ENG FAIL L, R	Caution	Beeper	Engine speed is below idle.
ENG IDLE DISAGREE	Advisory		One engine is at approach idle and the other engine is at minimum idle.
ENG LIMIT PROT L, R	Caution	Beeper	Engine control is operating in the alternate mode and commanded N1 exceeds maximum N1.
ENG REV LIMITED L, R	Advisory		Engine thrust reverser will not deploy or reverse thrust will be limited to idle on landing.
ENG REVERSER L, R	Advisory		Fault is detected in the affected engine reverser system.
ENG RPM LIMITED L, R	Advisory		Engine control is limiting affected engine thrust to prevent N1 or N2 from exceeding the RPM operating limit.
ENG SHUTDOWN	Caution	Beeper	Both engines were shutdown on the ground by the fuel control switches or fire switches.
ENG SHUTDOWN L, R	Caution	Beeper	Engine was shutdown by the fuel control switch or fire switch.
ENG THRUST L, R	Caution	Beeper	Engine is not producing commanded thrust.

Start

Message	Level	Aural	Condition
ENG AUTOSTART L, R	Caution	Beeper	Autostart has failed to start the engine.
ENG AUTOSTART OFF	Advisory		Engine autostart switch is OFF.
ENG START VALVE L, R	Advisory		Engine start valve is closed when commanded open.
ENG STARTER CUTOUT L, R	Caution	Beeper	Start/ignition selector remains in START or engine start valve is open when commanded close.

Ignition

Message	Level	Aural	Condition
CON IGNITION ON L, L+R, R	Memo		Indicates respective engine START/IGNITION selector CON position selected.

Fuel

Message	Level	Aural	Condition
ENG FUEL FILTER L, R	Advisory		Affected engine fuel filter contamination is approaching a level sufficient to cause filter bypass.
ENG FUEL VALVE L, R	Advisory		Engine fuel or spar valve position disagrees with commanded position.

Oil

Message	Level	Aural	Condition
ENG OIL FILTER L, R	Advisory		Affected engine oil filter contamination has caused filter bypass.
ENG OIL PRESS L, R	Caution	Beeper	Engine oil pressure is low.
ENG OIL TEMP L, R	Advisory		Engine oil temperature is high.

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FIRE PROTECTION SYSTEM DESCRIPTION**INTRODUCTION**

There are fire detection and extinguishing systems for the:

- APU
- Cargo compartments
- Engines
- Lavatories.

The flight deck crew rest compartment has a fire detection system, but no fire extinguishing system.

The engines also have overheat detection systems.

The main gear wheel wells have a fire detection system, but no fire extinguishing system.

Fire and overheat detection systems are powered by the battery bus. Fire extinguishing systems are powered by the hot battery bus.

Refer to the following sections for additional information:

- Section 6.1 - Air Systems, for descriptions of equipment smoke evacuation, and bleed duct leak and overheat detection.
- Section 6.2 - Anti-Ice, Rain, for a description of engine anti-ice system leak protection.

ENGINE FIRE PROTECTION

Engine fire protection consists of these systems:

- Engine fire and overheat detection
- Engine fire extinguishing.

Engine Fire and Overheat Detection

There are two detector loops in each engine nacelle. Each detector loop provides both fire and overheat detection. Normally, both loops must detect a fire or overheat condition to cause an engine fire warning or overheat caution.

If a fault is detected in one loop, the system automatically switches to single loop operation. If the operating loop senses a fire or overheat, the system provides the appropriate fire warning or overheat caution.

If there are faults in both detector loops in an engine nacelle, no fire or overheat detection is provided. The EICAS advisory message **DET FIRE ENG (L or R)** is displayed if the engine fire detection system fails.

Engine Fire Warning

The indications of an engine fire are:

- The fire bell sounds
- The master **WARNING** lights illuminate
- The EICAS warning message **FIRE ENG (L or R)** is displayed
- The engine fire switch **LEFT** or **RIGHT** fire warning light illuminates
- The engine fire switch unlocks
- The engine FUEL CONTROL (L or R) switch fire warning light illuminates.

Engine Overheat Caution

The indications of an engine overheat are:

- The caution beeper sounds
- The master **CAUTION** lights illuminate
- The EICAS caution message **OVERHEAT ENG (L or R)** is displayed.

Engine Fire Extinguishing

There are two engine fire extinguisher bottles. Either or both bottles can be discharged into either engine.

When the engine fire switch is pulled out, rotating the fire switch in either direction discharges a single extinguisher bottle into the associated engine. Rotating the engine fire switch in the other direction discharges the remaining extinguisher bottle into the same engine.

If an extinguisher bottle is discharged or has low pressure:

- The **ENG BTL (1 or 2) DISCH** light illuminates
- The EICAS advisory message **BOTTLE (1 or 2) DISCH ENG** is displayed.

APU FIRE PROTECTION

APU fire protection consists of these systems:

- APU fire detection
- APU fire extinguishing.

APU Fire Detection

The APU compartment has dual fire detector loops. There is no APU overheat detection.

Normally, both loops must detect a fire to produce a fire warning. An APU fire warning automatically shuts down the APU.

If a fault is detected in one loop, the system automatically switches to single loop operation. If the operating loop detects a fire, an APU fire warning occurs and the APU shuts down.

The EICAS advisory message **DET FIRE APU** is displayed if the APU fire detection system fails.

APU Fire Warning

The indications of an APU fire warning are:

- The fire bell sounds
- The master **WARNING** lights illuminate
- The EICAS warning message **FIRE APU** is displayed
- The APU fire switch fire warning light illuminates
- The APU fire switch unlocks.

APU Fire Extinguishing

There is one APU fire extinguisher bottle. When the APU fire switch is pulled out, rotating the switch in either direction discharges the extinguisher bottle into the APU compartment. If the bottle is discharged or has low pressure:

- The **APU BTL DISCH** light illuminates
- The EICAS advisory message **BOTTLE DISCH APU** is displayed.

When the airplane is on the ground with both engines shut down, a fire signal from either APU fire detector loop causes automatic APU shutdown and the extinguisher bottle automatically discharges.

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MAIN WHEEL WELL FIRE PROTECTION

The main wheel well has fire detection only. There is no fire extinguishing system. The nose wheel well does not have a fire detection system.

Main Wheel Well Fire Detection

The main wheel well fire detection system consists of dual fire detector loops.

Main Wheel Well Fire Warning

The indications for a main wheel well fire are:

- The fire bell sounds
- The EICAS warning message **FIRE WHEEL WELL** is displayed
- The master **WARNING** lights illuminate.

CARGO COMPARTMENT FIRE PROTECTION

Cargo compartment fire protection consists of these systems:

- Cargo compartment smoke detection
- Cargo compartment fire extinguishing.

Cargo Compartment Smoke Detection

The forward and aft cargo compartments each have smoke detectors. Each compartment is divided into three detection zones. If smoke is detected in any zone, a fire warning occurs.

Whenever cargo compartment smoke detection is inoperative, the EICAS advisory message **DET FIRE CARGO (FWD or AFT)** is displayed.

Cargo Compartment Fire Warning

The indications of a cargo compartment fire are:

- The fire bell sounds
- The master **WARNING** lights illuminate
- The EICAS warning message **FIRE CARGO (FWD or AFT)** is displayed
- The **CARGO FIRE (FWD or AFT)** fire warning light illuminates.

Cargo Compartment Fire Extinguishing

Five fire extinguisher bottles are installed for cargo compartment fire extinguishing. Pushing the FWD or AFT CARGO FIRE ARM switch (**ARMED** visible) arms the extinguishers.

In flight, pushing the CARGO FIRE DISCHARGE switch causes the immediate total discharge of two rapid dump-extinguishing bottles (1A and 1B) into the selected compartment. The bottles are identical and weigh approximately 65 lbs. each. The squib explosion opens the diaphragms in the dump bottles and in the selected flow valve. Nitrogen pressure pushes the halon from the bottles, through the open flow valve, and into the selected compartment. Pressure in the discharge line operates the in-line pressure switch. The switch gives the flight deck indication of bottle discharge. Once the squibs are fired the ELMS starts a twenty-minute timer. After twenty minutes, the ELMS fires the squibs for the remaining three metered bottles (2A, 2B and 2C). The metered bottles are identical and weigh approximately 80 lbs. each. Halon from the bottles goes through the filter/regulator and into the selected cargo compartment. The filter/regulator causes a slow and continuous flow of halon into the cargo compartment to keep the fire out.

If the airplane lands before the twenty-minute timer delay ends, only one metered bottle (2A) discharges at landing. The remaining two metered bottles (2B and 2C) do not discharge.

On the ground, if a CARGO FIRE DISCHARGE switch is pushed, two rapid dump-extinguishing bottles discharge into the selected compartment. The ELMS starts a twenty-minute timer. After twenty minutes the squib for metered bottle 2A fires. Metered bottles 2B and 2C do not discharge when the airplane is on the ground.

When cargo fire extinguisher bottle discharge is initiated:

- The **CARGO FIRE DISCHARGE** switch light illuminates when the first two extinguisher bottles begin to discharge.
- The EICAS advisory message **BOTTLE DISCH CARGO** is displayed when the first two extinguisher bottles have completely discharged.
- The **CARGO FIRE FWD/AFT** warning message is likely to remain after the fire is extinguished due to smoke in the cargo compartment.

CREW REST COMPARTMENT FIRE PROTECTION**Flight Deck Crew Rest Compartment Smoke Detection**

Smoke detectors are installed in the flight deck crew rest compartment. The EICAS caution message **SMOKE CREW REST F/D** indicates smoke in the flight deck crew rest compartment.

Lavatory Fire Protection

Lavatory fire protection consists of these systems:

- Lavatory fire detection
- Lavatory waste container fire extinguishing.

Lavatory Fire Detection

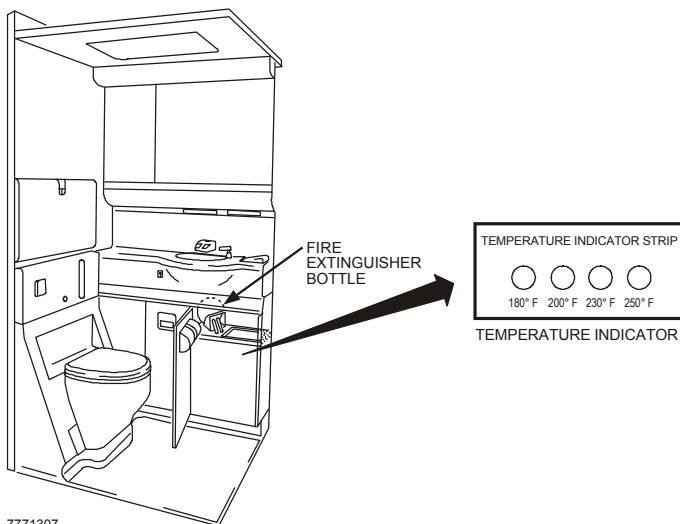
Each lavatory has a single smoke detector. If smoke is detected, an aural alert sounds in the lavatory and in the cabin. In addition, the lavatory call light flashes and the master call light at the associated attendant station illuminates. The EICAS advisory message **SMOKE LAVATORY** indicates smoke is detected in one of the lavatories.

Lavatory Fire Extinguishing System

An automatic fire extinguisher system is located beneath the sink area in each lavatory. The extinguisher discharges non-toxic freon gas through one, or both, of two heat-activated nozzles. Both nozzles discharge toward the towel disposal container. The color of the nozzle tips will change to an aluminum color when the extinguisher has discharged.

A temperature-indicator placard is located on the inside of the access door below each sink. White dots on the placard will turn black when exposed to high temperatures. If an indicator has turned black, or a nozzle tip has changed color, it should be assumed that the extinguisher has discharged. An inspection for fire damage should be made, the extinguisher replaced, and the temperature-indicator placard replaced before the next flight.

There is no flight deck indication.



7771307

FIRE AND OVERHEAT DETECTION SYSTEM FAULT TEST

The fire and overheat detection system has automatic and manual fault testing.

Fire and Overheat Detection System Automatic Fault Test

Fire and overheat detection system testing is automatic. The engine and APU systems continuously monitor the fire/overheat detector loops for faults. The cargo and wheel well systems continuously monitor for any system faults.

If a fault is detected, the system automatically reconfigures for single loop operation. Complete system failures are indicated by an EICAS advisory message for the failed system:

- **DET FIRE ENG (L or R)**
- **DET FIRE APU**
- **DET FIRE CARGO (FWD or AFT).**

Fire and Overheat Detection System Manual Fault Test

The fire and overheat detection systems can be tested manually by pushing and holding the FIRE/OVERHEAT TEST switch.

The indications for a manual fire and overheat detection system test are:

- The fire bell rings
- The nose wheel well APU fire warning horn sounds (on the ground)
- The EICAS warning message **FIRE TEST IN PROG** is displayed
- These lights illuminate:
 - The master **WARNING** lights
 - The **LEFT** and **RIGHT** engine fire warning lights
 - The APU fire warning light
 - The nose wheel well APU fire warning light
 - The **FWD** and **AFT CARGO FIRE** warning lights
 - The **LEFT** and **RIGHT FUEL CONTROL** switch fire warning lights.

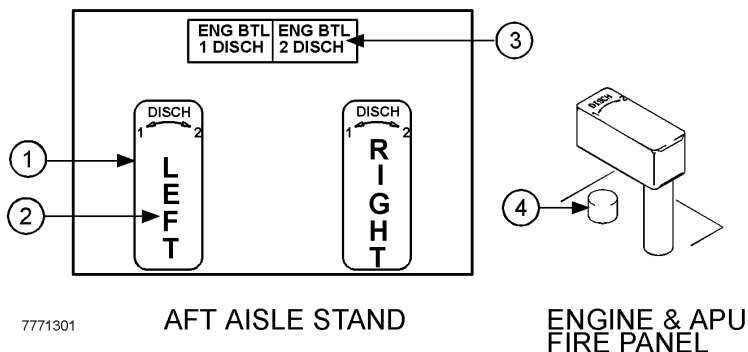
When the test is complete, the EICAS warning message **FIRE TEST PASS** or **FIRE TEST FAIL** replaces the **FIRE TEST IN PROG** message; the switch can be released. The appropriate system EICAS messages are displayed with the **FIRE TEST FAIL** message:

- **DET FIRE ENG (L or R)**
- **DET FIRE APU**
- **DET FIRE CARGO (FWD or AFT)**
- **DET FIRE WHEEL WELL**
- **DET OVERHEAT ENG (L or R).**

All test messages clear when the test switch is released. If the switch is released with the **FIRE TEST IN PROG** message displayed, the test ends without completing.

CONTROLS AND INDICATORS

ENGINE FIRE PROTECTION



ENGINE FIRE PANEL

① Engine Fire Switches

In (normal position, mechanically locked) - unlocks automatically for a fire warning, or when the FUEL CONTROL switch is in CUTOFF.

Out -

- Arms both engine fire extinguishers
- Closes the associated engine and spar fuel valves
- Closes the associated engine bleed air valves
- Trips the associated engine generator field and generator breaker
- Shuts off hydraulic fluid to the associated engine-driven hydraulic pump
- Depressurizes the associated engine-driven hydraulic pump
- Removes power from the thrust reverser isolation valve.

Rotate to position 1 or 2 - discharges the selected fire extinguisher into the engine.

② Engine Fire Warning Lights

Illuminated (red) -

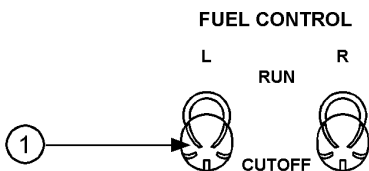
- An engine fire is detected, or
- The FIRE/OVERHEAT TEST switch is pushed.

③ Engine Bottle Discharged (**ENG BTL DISCH**) Lights

Illuminated (amber) - The extinguisher bottle is discharged or has low pressure.

④ Engine and APU Fire Override Switches

Push - Unlocks the fire switch.



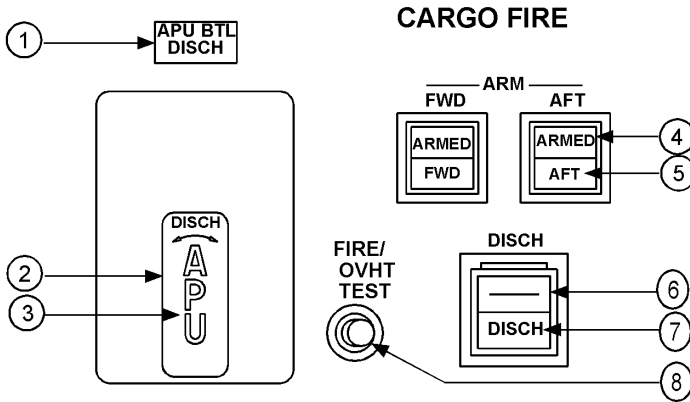
CONTROL STAND

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FUEL CONTROL SWITCHES**① FUEL CONTROL Switch Fire Warning Lights**

Illuminated (red) -

- An associated engine fire is detected, or
- The FIRE/OVERHEAT TEST switch is pushed.



OVERHEAD PANEL

7771303

APU AND CARGO FIRE PANEL**① APU Bottle Discharge (APU BTL DISCH) Light**

Illuminated (amber) - The extinguisher bottle is discharged or has low pressure.

② APU Fire Switch

In - Normal position, mechanically locked; unlocks automatically for a fire warning.

Out -

- Arms the APU fire extinguisher bottle
- Closes the APU fuel valve
- Closes the APU bleed air valves
- Closes the APU air inlet door
- Trips the APU generator field and generator breaker
- Shuts down the APU (if automatic shutdown does not occur).

Rotate - Either direction discharges the APU fire extinguisher into the APU compartment.

③ APU Fire Warning Light

Illuminated (red) -

- An APU fire is detected, or
- The FIRE/OVERHEAT TEST switch is pushed.

The APU automatically shuts down for a detected fire.

④ CARGO FIRE ARM Switches

ARMED -

- Arms all cargo fire extinguisher bottles
- Arms the selected compartment extinguisher valve
- Turns off both lower recirculation fans
- Shuts down cargo heat
- Commands the packs to provide the minimum air flow required to provide pressurization
- Shuts down the bulk cargo compartment ventilation system operation (aft cargo fire only)
- Shuts down the lavatory/galley vent fan (aft cargo fire only)
- Puts the equipment cooling system into the override mode (forward cargo fire only).

Off (blank) - normal position.

⑤ CARGO FIRE Warning Lights

Illuminated (red) -

- Associated cargo compartment smoke is detected, or
- The FIRE/OVERHEAT TEST switch is pushed.

⑥ CARGO FIRE Discharge (DISCH) Switch

Push - discharges the fire extinguisher bottles into the ARMED cargo compartment.

⑦ CARGO FIRE Discharge (DISCH) Light

Illuminated (amber) - The first two extinguisher bottles have begun to discharge.

⑧ FIRE/OVERHEAT TEST Switch

Push and hold -

- Sends fire/overheat test signals to the engine, APU, wheel well, and cargo compartment fire detector systems
- Tests flight deck fire and overheat indications (see Fire and Overheat Detection System Manual Fault Test, Section 6.7).

Illuminated (amber) - The APU fire extinguisher is armed.

④ **APU BOTTLE DISCHARGED Light**

Illuminated (amber) - The extinguisher bottle pressure is low.

⑤ **APU BOTTLE DISCHARGE Switch**

Push - Discharges the APU fire extinguisher into the APU compartment.

⑥ **APU FIRE SHUTDOWN Switch**

Push (red) -

- Shuts down the APU
- Arms the APU fire extinguisher.

FIRE PROTECTION SYSTEM EICAS MESSAGES

The following EICAS messages can be displayed.

Airplane System EICAS Messages

Message	Level	Aural	Condition
BOTTLE 1, 2 DISCH ENG	Advisory		Engine fire extinguisher bottle 1 or bottle 2 pressure is low.
BOTTLE DISCH APU	Advisory		APU fire extinguisher bottle pressure is low.
BOTTLE DISCH CARGO	Advisory		Both rapid discharge cargo fire extinguisher bottle pressures are low.
DET FIRE APU	Advisory		APU fire detection is inoperative.
DET FIRE CARGO AFT, FWD	Advisory		Affected cargo compartment smoke detection is inoperative.
DET FIRE ENG L, R	Advisory		Affected engine fire detection is inoperative.
FIRE APU	Warning	Fire Bell	Fire is detected in the APU.
FIRE CARGO AFT, FWD	Warning	Fire Bell	Smoke is detected in the affected cargo compartment.
FIRE ENG L, R	Warning	Fire Bell	Fire is detected in the engine.
FIRE WHEEL WELL	Warning	Fire Bell	Fire is detected in a main wheel well.
OVERHEAT ENG L, R	Caution	Beeper	Overheat is detected in the affected nacelle.

Cabin System EICAS Messages

Message	Level	Aural	Condition
SMOKE CREW REST F/D	Caution		Smoke is detected in flight deck crew rest compartment.
SMOKE LAVATORY	Advisory		Smoke is detected in one of the lavatories.

System Test Messages

The following messages are associated only with the manually-initiated fire test.

Message	Level	Aural	Condition
DET FIRE WHEEL WELL	Advisory		Wheel well fire detection system is failed.
DET OVERHEAT ENG L, R	Advisory		Affected engine overheat detection system is failed.
FIRE TEST FAIL	Warning		One or more fire/overheat detection systems have failed to successfully complete the manually initiated fire overheat test.
FIRE TEST IN PROG	Warning		A manually initiated fire/overheat detection system test is in progress.
FIRE TEST PASS	Warning		A manually initiated test of the fire/overheat detection system has been completed.

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FLIGHT CONTROL SYSTEM OVERVIEW**INTRODUCTION**

The primary flight control system is an electronically operated (fly-by-wire) / hydraulically actuated, highly redundant system with three operating modes: normal, secondary and direct. In addition, there is a mechanical backup for the unlikely event of complete electrical shutdown.

The primary flight control system uses conventional control wheel, column, and pedal inputs from the pilot to electronically command the flight control surfaces. The pilot always has ultimate control authority; the flight control computers cannot override a pilot command. The system provides conventional control feel and pitch responses to speed and trim changes. The system electronic components provide enhanced handling qualities and reduce pilot workload.

The secondary flight controls, consisting of flaps and slats, are hydraulically actuated with an electrically powered backup system.

PILOT CONTROLS

The pilot controls consist of:

- Two control columns
- Two control wheels
- Two pairs of rudder pedals
- Control wheel pitch trim switches
- Alternate pitch trim levers
- The speedbrake lever
- The flap lever
- Aileron trim switches
- Rudder trim switch
- Manual rudder trim cancel switch.

The columns and wheels are connected through jam override mechanisms. If a jam occurs in a column or wheel, the pilots can maintain control by applying force to the other column or wheel to overcome the jam.

The rudder pedals are rigidly connected between the two sides.

The speedbrake lever allows manual or automatic symmetric actuation of the spoilers.

The pilot controls command these system electronic components:

- Four Actuator Control Electronics (ACEs)
- Three Primary Flight Computers (PFCs).

The ACEs receive input signals from pilot controls and send control signals to the flight control surfaces. The distribution of ACE signals to flight control surfaces is designed so no ACE controls all surfaces in any axis, which provides redundancy and improves reliability.

In the normal and secondary mode, the ACEs send the pilot inputs to the PFCs. The PFCs use information from other airplane systems (such as air data, inertial data, flap and slat position, engine thrust, and radio altitude) to compute control surface commands for enhanced handling qualities. The ACEs receive enhanced control commands back from the PFCs and use the commands to position the flight control surfaces.

The autopilot sends commands directly to the PFCs. See Section 6.4, Automatic Flight.

The EICAS caution message **FLIGHT CONTROLS** is displayed if:

- Multiple ACE and/or hydraulic system failures cause the loss of a significant number of control surfaces, or
- Other flight control system faults are detected.

FLIGHT CONTROL SURFACES

Elevators (2)

Flaperons (2)

Located between the inboard and outboard flaps on both wings. They are used for roll control, additionally, for increased lift, the flaperons move down and aft in proportion to trailing edge flap extension

Ailerons (2)

Located outboard of the outboard flaps on each wing. For increased lift, the ailerons move down for flaps 5, 15, and 20, to improve takeoff performance. The ailerons are locked out during high-speed flight.

Spoilers (14)

Symmetric spoilers are used as speedbrakes; asymmetric spoilers assist in roll control.

Spoilers 5 and 10 are locked out during high-speed flight; the remaining spoilers provide sufficient roll control. During low speed flight, these panels augment roll control.

Rudder

A single rudder provides yaw control. The lower portion of the rudder has a hinged section that deflects twice as far as the main rudder surface to provide additional yaw authority. During takeoff, the rudder becomes aerodynamically effective at approximately 60 knots.

Flaps (4)

One inboard and one outboard flap on the trailing edge of each wing.

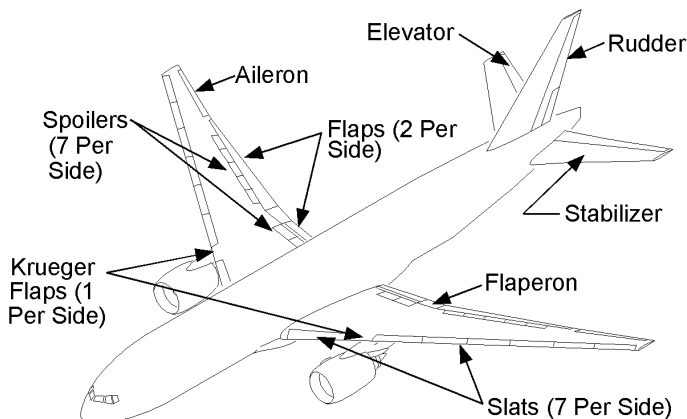
Slats (14)

One inboard and six outboard slats on the leading edge of each wing.

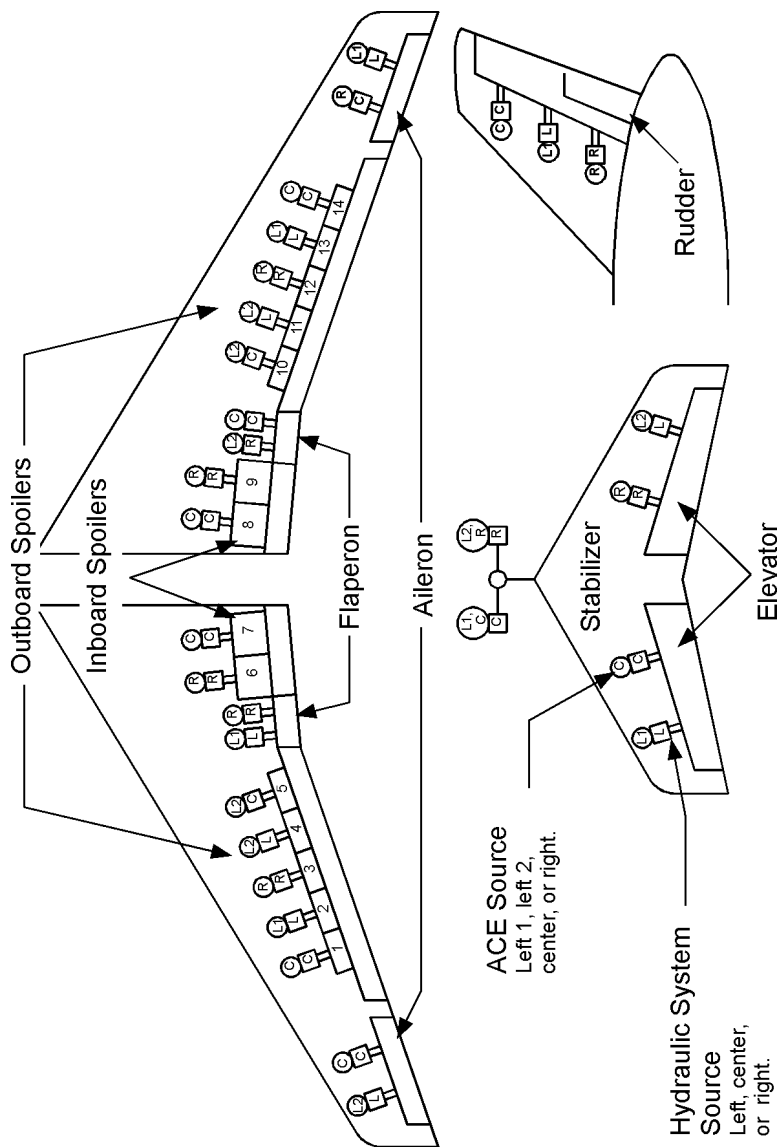
Krueger Flaps (2)

Two position flap on the leading edge of each wing that provides a seal between the inboard slat and engine nacelle.

FLIGHT CONTROL SURFACE LOCATIONS



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**ACTUATOR CONTROL ELECTRONICS / HYDRAULIC
POWER DISTRIBUTION**

FLY-BY-WIRE SYSTEM

OVERVIEW

There are three primary flight control system fly-by-wire operating modes:

- Normal
- Secondary
- Direct.

All the modes use the same pilot controls and flight control surfaces.

In the event of a complete electrical shutdown there is a mechanical backup system for operating selected flight controls.

NORMAL MODE

In the normal mode during manual flight, the ACEs receive pilot control inputs and send these signals to the three PFCs. The PFCs verify these signals and information from other airplane systems to compute control surface commands for enhanced handling qualities, and then send commands back to the ACEs. The ACEs send the enhanced signal causing the flight control surface actuators to move.

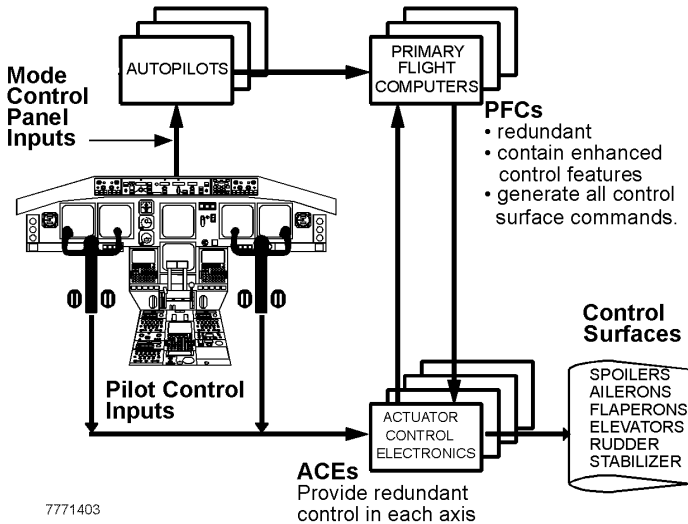
When the autopilot is engaged, the autopilot system sends commands directly to the PFCs. The PFCs generate control surface commands, which are then sent to the ACEs in the same manner as pilot control inputs. The autopilot commands move the pilot controls to provide indications of what the autopilot is doing. If the pilot overrides the autopilot with control inputs, the PFCs disconnect the autopilot and use the pilot control inputs. The autopilot is only available during normal mode operation. Refer to Section 6.4, Automatic Flight, for autopilot operation.

The PFCs automatically perform a self-test when the hydraulic systems are shut down. During the test, various EICAS alert and status messages display, trim indicator information blinks, and various failure indications display on the flight controls synoptic. These messages disappear, and the indicators and synoptic return to normal, when the self-test is complete (approximately two minutes after the EICAS caution message **HYD PRESS SYS L+C+R** is displayed).

A flight envelope protection system reduces the possibility of inadvertently exceeding the airplane's flight envelope. The flight envelope protection system provides crew awareness of envelope margins through tactile, aural, and visual cues. The protection functions do not reduce pilot control authority. The protection functions are described later in this section and include stall protection, overspeed protection, and roll envelope bank angle protection.

NORMAL MODE OPERATION

Pilot or autopilot control inputs command the PFCs to generate control surface commands.



7771403

Normal Mode Pitch Control

Overview

In the normal mode, airplane pitch control characteristics are like conventional airplanes. Unlike conventional airplanes, the control column does not directly position the elevator in flight. The control column commands the PFCs to generate a pitch maneuver. The PFCs automatically position the elevator and the stabilizer to generate the commanded maneuver. The PFCs constantly monitor airplane response to pilot commands and reposition the elevator and stabilizer to carry out these commands. Airplane pitch responses to thrust changes, gear configuration changes, and turbulence are automatically minimized by PFC control surface commands.

The PFCs also provide compensation for flap and speedbrake configuration changes, and turns up to 30° of bank. The PFCs automatically control pitch to maintain a relatively constant flight path. This eliminates the need for the pilot to make control column inputs to compensate for these factors. For turns up to 30° of bank, the pilot does not need to add additional column back pressure to maintain altitude. For turns of more than 30° of bank, the pilot does need to add column back pressure.

When the autopilot is not engaged, as airspeed changes, the pitch control system provides conventional pitch characteristics by requiring the pilot to make control column inputs or trim changes to maintain a constant flight path. Manual trim is necessary only when changing airspeed. Manual trim is not necessary when changing configuration.

Pitch Trim

Primary Pitch Trim

Primary pitch trim is controlled by the dual pitch trim switches on each control wheel. Both switches must be moved to command trim changes. The primary pitch trim switches are inhibited when the autopilot is engaged. Pitch trim does not move the control column.

In the normal mode, primary pitch trim operates differently on the ground than it does in flight. On the ground, the stabilizer is directly positioned when the pilot uses the pitch trim switches. In flight, the pitch trim switches do not position the stabilizer directly; they provide inputs to change the trim reference speed. The trim reference speed is the speed at which the airplane would eventually stabilize if there were no control column inputs. Once the control column forces are trimmed to zero, the airplane maintains a constant speed with no column inputs. Thrust changes result in a relatively constant indicated airspeed climb or descent, with no trim inputs needed unless airspeed changes.

When pilot trim inputs are made, the PFCs analyze the command and generate signals to move the elevators to achieve the trim change, then moves the stabilizer to streamline the elevator. Stabilizer motion may also automatically occur to streamline the stabilizer and elevator for thrust and configuration changes.

Alternate Pitch Trim

Alternate pitch trim is controlled by the dual alternate pitch trim levers on the aisle stand. Both levers must be moved to command trim changes. These levers move the stabilizer directly (all modes) and also change the reference airspeed in flight (normal mode). The alternate pitch trim levers are directly linked to the stabilizer via control cables. Alternate pitch trim commands have priority over wheel pitch trim commands in all flight control modes.

Moving the alternate pitch trim levers with the autopilot engaged does not disconnect the autopilot, but does move the stabilizer. Moving the alternate pitch trim levers during stall or overspeed protection does move the stabilizer, but does not remove column forces.

Note: The alternate pitch trim levers should not be used with the autopilot engaged or during stall or overspeed protection.

Elevator Feel

The PFCs calculate feel commands based on airspeed. In general, control column forces increase:

- As airspeed increases or
- As column displacement increases.

Stabilizer

The stabilizer is powered by the center and right hydraulic systems. Stabilizer position commands are sent to the stabilizer trim control modules, which control hydraulic power to the stabilizer. There are two modules, one for each stabilizer hydraulic source.

Stabilizer Position Indication and Greenband

Stabilizer position is displayed on two stabilizer position indicators located on the aisle stand. Stabilizer position is also displayed on the flight controls synoptic.

The stabilizer position indicators also display the takeoff green band indication. The green band automatically displays the acceptable range for takeoff stabilizer positions. There are three greenband segments that can be illuminated for takeoff:

- The midband
- The nose down band (added forward of the midband)
- The nose up band (added aft of the midband).

The greenband is calculated using the FMC inputs of CG, gross weight, and takeoff thrust. A nose gear pressure switch provides an automatic crosscheck of the CG to ensure that the correct greenband has been selected. When either the nose up or nose down band is displayed, the pressure switch position is compared to the computed greenband. The nose gear oleo pressure switch does not crosscheck the CG when the midband segment is selected. The EICAS advisory message **STAB GREENBAND** is displayed if the pressure switch and the greenband disagree. If the stabilizer signal is not present or is invalid, the greenband and the pointer are not displayed.

Stabilizer Non-Normal Operation

If uncommanded stabilizer motion is sensed, hydraulic power to the stabilizer control module that caused the motion is automatically shut off. If a module is inoperative due to an automatic shutdown or another failure, the EICAS advisory message **STABILIZER C** or **STABILIZER R** is displayed. The stabilizer remains operative through the remaining stabilizer control module.

If both stabilizer control modules automatically shut down or fail, the EICAS warning message **STABILIZER** is displayed. The **STABILIZER** warning is also displayed if automatic shutdown fails to stop uncommanded motion.

The center and right stabilizer cutout switches, located on the aisle stand, control hydraulic power to the respective stabilizer control module. Placing both switches in the **CUTOUT** position removes all hydraulic power from the stabilizer. The EICAS advisory message **STABILIZER CUTOUT** is displayed when both stabilizer cutout switches are in the **CUTOUT** position. The **STABILIZER** warning message is no longer displayed.

In the normal flight control mode, when the stabilizer is manually shut down or failed, pitch trim is still available. Pilot pitch trim inputs change the trim reference speed and then reposition the elevators to trim the airplane.

The control column can be used to interrupt pitch trim commands from the wheel pitch trim switches. This feature allows the pilot to quickly stop uncommanded trim changes due to stuck pitch trim switches. The pitch trim commands are interrupted if the control column is displaced in the opposing direction.

Automatic Protection Features

Pitch Envelope Protection

The pitch envelope protection functions include:

- Stall protection
- Overspeed protection.

Stall protection reduces the likelihood of inadvertently exceeding the stall angle of attack by providing enhanced crew awareness of the approach to a stall or to a stalled condition.

Stall protection limits the speed to which the airplane can be trimmed. At approximately the minimum maneuvering speed (approximately the top of the amber band), stall protection limits the trim reference speed so that trim is inhibited in the nose up direction. The pilot must apply continuous aft column force to maintain airspeed below the minimum maneuvering speed. Use of the alternate pitch trim levers does not reduce the column forces. When flying near stall speed, the column force increases to a higher level than would occur for an equivalent out-of-trim condition above the minimum maneuvering speed.

When armed, the auto throttles support stall protection. If speed decreases to near stick shaker activation, the autothrottle engages in the appropriate mode (**SPD** or **THR REF**) and advances thrust to maintain minimum maneuvering speed or the speed set in the mode control panel speed window, whichever is greater. The EICAS message **AIRSPEED LOW** is displayed.

Note: When the pitch mode is FLCH or TOGA, or the airplane is below 400 feet above the airport on takeoff, or below 100 feet radio altitude on approach, the autothrottle will not automatically engage.

Refer to Section 6.10, Flight Instruments, Displays, for PFD indications.

Refer to Section 6.4, Automatic Flight, for mode control panel and autothrottle operation.

Overspeed protection limits the speed to which the airplane can be trimmed. At V_{MO}/M_{MO} , overspeed protection limits the trim reference speed so that trim is inhibited in the nose down direction. The pilot must apply continuous forward column force to maintain airspeed above V_{MO}/M_{MO} . Use of the alternate pitch trim levers does not reduce column forces.

Normal Mode Roll Control

Overview

Roll control is similar to conventional airplanes. Aileron and flaperon surface deflections are proportional to control wheel displacement. Spoilers begin to extend to augment roll control after several degrees of control wheel rotation. Control wheel forces increase as control displacement increases. Control wheel forces do not change with airspeed changes. The ailerons are locked out at high speeds.

Spoilers

There are 7 sets of spoilers, 5 outboard and 2 inboard, on the upper surface of each wing. The spoilers are numbered from left to right, 1 through 14. Spoilers on opposing wings are symmetrically paired.

The spoilers supplement roll control in response to control wheel commands. Spoiler panels 5 and 10 are locked out during cruise, depending on altitude and airspeed.

Spoilers 4 and 11 are mechanically controlled through a cable from the control wheel. These spoilers are available for roll control until the speedbrake lever is moved to near the UP position, when they function as speedbrakes only.

All three hydraulic systems supply the spoilers. Each hydraulic system is dedicated to a different set of spoiler pairs to provide isolation and maintain symmetric operation in the event of hydraulic system failure. If a single spoiler fails, the corresponding spoiler on the other wing retracts. Failure of a single or multiple spoiler pairs cause the EICAS advisory message **SPOILERS** to display.

Speedbrakes

The 14 spoiler panels are used as speedbrakes to increase drag and reduce lift, both in flight and on the ground. In the normal mode, when used as speedbrakes, spoilers 5 and 10 are available as ground speedbrakes only.

The speedbrakes are controlled by the speedbrake lever located on the control stand. The lever has three marked positions:

- DOWN
- ARMED
- UP

The speedbrake lever can be placed in intermediate positions between ARMED and UP.

In the ARMED position, the speedbrake lever is driven aft to the UP position when the landing gear is fully on the ground (not tilted) and the thrust levers are at idle.

The EICAS memo message **SPEEDBRAKE ARMED** is displayed when the speedbrake lever is armed.

On the ground when either reverse thrust lever is moved to the reverse idle detent, the speedbrakes automatically extend. The speedbrake lever does not need to be in the ARMED position. A mechanical link between the speedbrake lever and the reverse thrust levers raises the speedbrake lever out of the DOWN detent. The speedbrake lever is then driven aft and the speedbrakes extend. If either thrust lever is advanced to a takeoff position, the speedbrake lever is driven to the down position.

The EICAS message **SPEEDBRAKE EXTENDED** is displayed if speedbrakes are extended when flaps are in the landing position, radio altitude is between 15 feet and 800 feet, or the thrust lever is not closed.

Aileron Trim

Dual aileron trim switches located on the aisle stand must be pushed simultaneously to command trim changes. The amount of aileron trim is indicated on a scale on the top of each control column.

Aileron trim is inhibited when the autopilot is engaged.

Automatic Protection Features

Roll Envelope Bank Angle Protection

Bank angle protection reduces the likelihood of exceeding the bank angle boundary due to external disturbances, system failures, or inappropriate pilot action.

Bank angle protection provides roll control wheel inputs when airplane bank angle exceeds approximately 35°. If the boundary is exceeded, the control wheel force rolls the airplane back within 30° of bank. The pilot can override this roll command. Maximum control wheel deflection always commands maximum control surface deflection. The autopilot disengage bar disables bank angle protection.

Excessive bank angles are indicated on the PFD bank indicator. The indicator changes color to amber at bank angles exceeding 35°. Refer to Section 6.10, Flight Instruments, Displays, for PFD indications.

Normal Mode Yaw Control

Yaw control operation is similar to a conventional airplane. Rudder surface deflections are proportional to rudder pedal movements.

Pedal forces increase as pedal displacement increases. Pedal forces do not change with airspeed changes.

The rudder ratio changer automatically reduces rudder deflection (for a given pedal input) as airspeed increases. This protects the vertical tail structure from stresses resulting from large rudder surface deflections at high airspeeds. Sufficient rudder authority is provided at all airspeeds to maintain airplane control in engine-out conditions, as well as during takeoffs and landings in crosswinds.

Rudder Trim

The rudder trim control can be used to command manual rudder trim in all three flight control modes. Two rudder trim speeds are available. Low rate rudder trim is commanded by rotating the control to the detent. High rate rudder trim is commanded by rotating the control past the detent. MANUAL TRIM CANCEL switch actuation causes manually set rudder trim to return to zero at the high trim rate. The switch has no effect on rudder trim inputs from TAC.

Automatic Protection Features

Thrust Asymmetry Compensation

The Thrust Asymmetry Compensation (TAC) system significantly reduces uncommanded flight path changes associated with an engine failure. TAC continually monitors engine data to determine the thrust level from each engine. If the thrust level on one engine differs by 10 percent or more from the other engine, TAC automatically adds rudder to minimize yaw. When TAC is operating, the pilot can still recognize the initial onset of an engine failure through airplane roll/yaw cues. These roll/yaw cues are greatly reduced when compared to an airplane operating without TAC. After several seconds, TAC applies sufficient rudder to make it possible for the pilot or autopilot to center the control wheel. The amount of rudder used is proportional to the engine thrust difference. Rudder movement is backdriven through the rudder pedals and the rudder trim indicator to provide rudder control awareness to the pilot.

TAC is available except:

- When airspeed is below 70 knots on the ground, or
- When reverse thrust is applied.

TAC can be manually overridden by making manual rudder pedal inputs. TAC is only available in the normal flight control mode. To manually disarm TAC, push the **THRUST ASYM COMP** switch on the overhead panel. If TAC is automatically or manually disconnected, the EICAS advisory message **THRUST ASYM COMP** displays.

Wheel to Rudder Cross-Tie

A wheel to rudder cross-tie function provides the capability of being able to control the initial effects of an engine failure using control wheel inputs only. Control wheel inputs can deflect the rudder up to 8 degrees.

The wheel to rudder cross-tie is separate from the TAC system and operates in flight below 210 knots in the normal mode.

Gust Suppression

In the normal mode, a gust suppression function reduces the effects of lateral gusts and improves lateral ride quality through a combination of yaw and roll commands. Operation does not result in either rudder or control wheel movement.

Yaw Damping

In the normal mode, the yaw damping function provides turn coordination and Dutch roll damping.

SECONDARY MODE

When the PFCs can no longer support the normal mode due to internal faults or lack of required information from other airplane systems, they automatically revert to the secondary mode. The ACEs continue to receive pilot control inputs and send these signals to the three PFCs. However, the PFCs use simplified computations to generate flight control surfaces commands. These simplified commands are sent back to the ACEs, where they are sent to the control surface actuators the same way as in the normal mode.

In the secondary mode, all flight control surfaces remain operable; however, the elevator and rudder are more sensitive at some airspeeds.

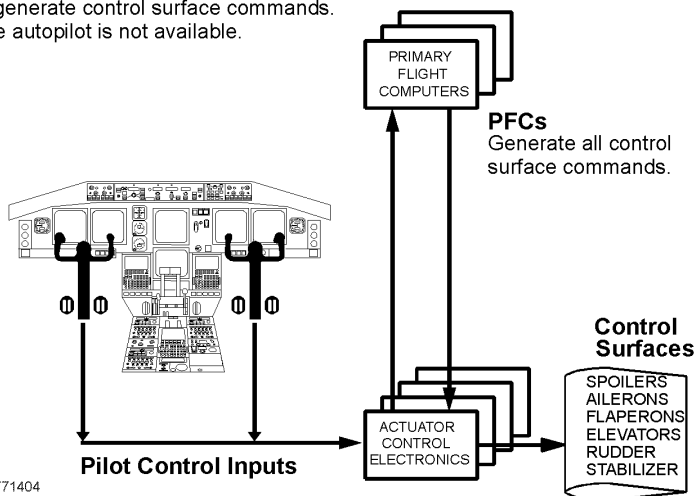
The following functions are not available in the secondary mode:

- Autopilot
- Auto speedbrakes
- Envelope protection
- Thrust asymmetry compensation
- Wheel to rudder cross-tie
- Gust suppression
- Yaw damping (may be degraded or inoperative).

The EICAS caution message **FLIGHT CONTROL MODE** is displayed when the primary flight control system is in the secondary mode. The secondary mode cannot be manually selected.

SECONDARY MODE OPERATION

Pilot control inputs command the PFCs to generate control surface commands. The autopilot is not available.



DIRECT MODE

The ACEs automatically transition to the direct mode when they detect the failure of all three PFCs or lose communication with the PFCs. The direct mode can also be manually selected by moving the PRIMARY FLIGHT COMPUTERS DISCONNECT switch to DISC.

In the direct mode, pilot inputs received by the ACEs are sent directly to the control surface actuators.

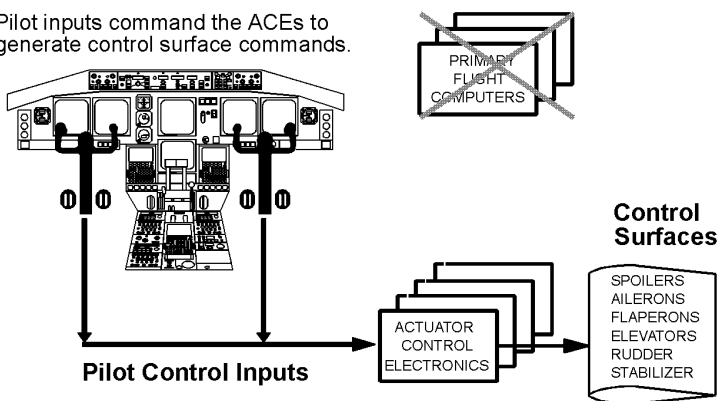
The direct mode provides full airplane control for continued safe flight and landing. Airplane handling qualities are approximately the same as in the secondary mode. The EICAS caution message **PRI FLIGHT COMPUTERS** is displayed when the system is in the direct mode.

In the direct mode, the following functions are not available:

- Autopilot
- Auto speedbrakes
- Envelope protection
- Thrust asymmetry compensation
- Wheel to rudder cross-tie
- Gust suppression
- Yaw damping
- Manual rudder trim cancel switch.

DIRECT MODE OPERATION

Pilot inputs command the ACEs to generate control surface commands.



7771405

Secondary and Direct Mode Pitch Control

Airplane pitch control is somewhat different in the secondary and direct flight control modes. The control columns now command a proportional elevator deflection instead of a maneuver command. Secondary and direct modes do not provide automatic pitch compensation for:

- Thrust changes
- Gear configuration changes
- Turbulence
- Flap and speedbrake configuration changes
- Turns to 30° bank angle.

In secondary and direct modes, the elevator variable feel system provides two feel force levels instead of a continuous variation with airspeed. The force levels change with flap position. With the flaps up, the feel forces provide maneuver force levels that discourage overcontrol in the pitch axis at high speeds. With flaps extended (flaps 1 or greater), the feel forces decrease to provide force levels appropriate for approach and landing.

In the secondary and direct modes, both the primary pitch trim switches and the alternate pitch trim levers move the stabilizer directly. There is no trim reference speed.

Secondary and Direct Mode Roll Control

Roll control in the secondary and direct modes is very similar to roll control in the normal mode. Bank angle protection is not available in either the secondary or direct mode. Spoilers 5 and 10 are always locked out.

Speedbrakes

In the secondary and direct modes automatic speedbrakes are not available, and spoiler panels 4, 5, 10, and 11 are locked out as speedbrakes.

Secondary and Direct Mode Yaw Control

Secondary and direct mode yaw control is similar to normal mode yaw control. Pedal feel forces are unchanged from normal mode; however, rudder response is slightly different.

In secondary and direct modes, the rudder ratio changer is degraded to two fixed ratios determined by flap position. With flaps up, the rudder response to pedal inputs is less than with the flaps down.

MECHANICAL BACKUP

In the unlikely event of a complete electrical system shutdown, cables from the flight deck to the stabilizer and selected spoilers allow the pilot to fly straight and level until the electrical system is restarted.

The alternate pitch trim levers must be used to move the stabilizer. The levers move valves in the stabilizer trim control modules and this sends hydraulic fluid to move the stabilizer

Spoilers 4 and 11 are cable-connected to the control wheel. The cables move valves in the spoiler hydraulic actuators that directly move the spoiler panels.

FLAPS AND SLATS

OVERVIEW

The flaps and slats are high lift devices that increase wing lift and decrease stall speed during takeoff, approach, and landing.

The airplane has an inboard and an outboard flap on the trailing edge of each wing, and one inboard and six outboard slats on the leading edge. A two-position Krueger flap provides a seal between the inboard slat and engine nacelle on each wing.

Flaps 5, 15, and 20 are takeoff flap positions. Flaps 25 and 30 are landing flap positions. Flaps 20 is used for some non-normal landing conditions.

To protect against inadvertent deployment during cruise, flap and slat extension from the UP position is inhibited when speed is more than 265 knots or altitude is above approximately 20,000 feet.

FLAP AND SLAT OPERATING MODES

Three modes of flap and slat operation are possible:

- Primary (hydraulic)
- Secondary (electric)
- Alternate (electric)

The flaps and slats can operate independently in either the primary or secondary mode. However, independent flap and slat operation in the alternate mode is not possible.

Primary mode hydraulic power is supplied by the center hydraulic system. The left and right AC busses supply secondary and alternate mode electrical power.

Primary Mode

In the primary mode, the flaps and slats are positioned by hydraulic motors as commanded by the flap lever.

Flap and Slat Sequencing

When the flap lever is in the UP detent, all flaps and slats are commanded retracted. Moving the flap lever aft allows selection of flap detent positions 1, 5, 15, 20, 25 and 30. The flaps and slats sequence so that the slats extend first and retract last.

Starting from flaps UP, selection of flaps 1 commands the slats to move to the midrange (sealed) takeoff position and the Kreuger flaps extend. The trailing edge flaps remain retracted.

Selection of the flaps 5, 15, and 20 positions commands the flaps to move to the position selected. The slats remain in the midrange (sealed) position. Flaps 5, 15, and 20 are takeoff positions.

Selection of flaps 25 commands both the flaps and slats to move to landing positions. The slats extend first to the down (gapped) position, then the flaps extend to the landing flaps 25 position.

Selection of flaps 30 commands the flaps to extend to the primary landing position. During retraction, flap and slat sequencing is reversed.

The mechanical gate at the flaps 20 detent prevents inadvertent retraction of the flaps past the go-around flap setting. The mechanical gate at flaps 1 prevents inadvertent retraction of the slats past the midrange (sealed) position.

Flap Load Relief

In the primary mode, the flap load relief system protects the flaps from excessive air loads. If flap airspeed placard limits are exceeded with the flaps in the 15 through 30 positions, LOAD RELIEF is displayed and the flaps automatically retract to a position appropriate to the airspeed. Load relief retraction is limited to flaps 5.

When airspeed is reduced, the flaps automatically re-extend as airspeed allows. Re-extension is limited to the commanded flap position.

If a flap overspeed exists, load relief prevents flap extension beyond the 5, 15, 20, or 25 positions until airspeed is sufficiently reduced. Flap load relief is available only in the primary mode. The EICAS flap display indicates an in-transit flap condition and shows actual flap position. The flap lever does not move during flap load relief operation. Load relief for slats is not required in the primary mode.

Autoslats

The autoslat system enhances airplane stall characteristics. Upon receiving a signal from the stall warning system, the slats automatically extend from the midrange position to the down gapped position. The gapped position improves stall handling characteristics. The slats retract a few seconds after the signal is removed.

Autoslat operation is armed at flaps 1, 5, 15 and 20 and is available only in the primary flap mode.

Uncommanded Flap or Slat Motion

Uncommanded motion is detected when the slats or flaps:

- Move away from the commanded position,
- Continue to move after reaching a commanded position, or
- Move in a direction opposite to that commanded.

If the flap or slat is operating in the primary mode, uncommanded motion first causes an automatic transfer to the secondary mode. The EICAS message **FLAPS PRIMARY FAIL** or **SLATS PRIMARY FAIL** is displayed. If motion continues, the system shuts down. The EICAS message **FLAPS DRIVE** or **SLATS DRIVE** is displayed.

Flap and Slat Asymmetry Detection

Asymmetrical flap and slat protection is available in the primary and secondary modes.

A detection system detects asymmetrical extension or retraction of an individual flap. After detection, the flap drive shuts down and the EICAS message **FLAPS DRIVE** is displayed.

A detection system detects slat asymmetry. Loss of all but the most outboard slats on each wing is also detected. When slat loss or asymmetry occurs, the system shuts down the slat drive and displays the **SLATS DRIVE** EICAS message.

Secondary Mode

The secondary mode is automatically engaged whenever the primary mode fails to move the flaps or slats to the selected position. Once engaged, the secondary mode remains engaged until the affected system surfaces are fully retracted or center hydraulic system pressure is restored.

In the secondary mode, the flaps and slats are positioned by electric motors as commanded by the flap lever. Because autoslats are unavailable, the slats are gapped at all flap positions to improve stall handling characteristics.

If the slats are in the midrange (sealed) position (flaps 1 through 20) when the secondary mode is engaged, they remain in that position until the flaps are retracted to UP, or extended beyond 20.

On the ground, secondary electric mode extension or retraction is inhibited when groundspeed is less than 40 knots, center hydraulic system pressure is low, and two of the following three items are true:

- Left engine N_2 is less than 50 percent,
- Right engine N_2 is less than 50 percent,
- Primary external power is available.

Slat Load Relief

Slat load relief is available in the secondary mode. If airspeed exceeds 239 knots with the slats down (gapped), they retract to the midrange (sealed) position and LOAD RELIEF is displayed. The slats will not extend beyond the midrange position if airspeed is greater than 239 knots until airspeed is reduced.

Alternate Mode

The alternate mode allows direct manual operation of the flaps and slats through the secondary drive electric motors. The alternate flaps ARM switch:

- Arms the alternate mode (disables primary and secondary mode operation)
- Arms the alternate flap selector (disables the flap lever control)
- Engages the electric motors.

The three-position alternate flaps selector extends and retracts the flaps and slats. The flaps and slats extend simultaneously, but slat retraction is inhibited until the flaps are up. Alternate mode flap and slat extension is limited to slats midrange (sealed) and flaps 20. Asymmetry protection, uncommanded motion protection, autoslats, and flap/slat load relief are not available in the alternate mode.

The alternate mode must be manually selected. Slat and flap operation time in the secondary and alternate modes is greatly increased.

Do not use the alternate mode on the ground.

FLAP INDICATIONS

Flap position indications are displayed on the primary EICAS display. A single vertical indicator displays combined flap and slat position. The position commanded by the flap lever is also displayed. Ten seconds after all flaps and slats are up, the entire indication is no longer displayed. A loss of position sensing removes the tape fill and command bars.

If flap/slat control is in the secondary or alternate mode, or if any non-normal condition is detected, an expanded flap indication is displayed automatically. The position of the left and right flaps and slats are separately indicated.

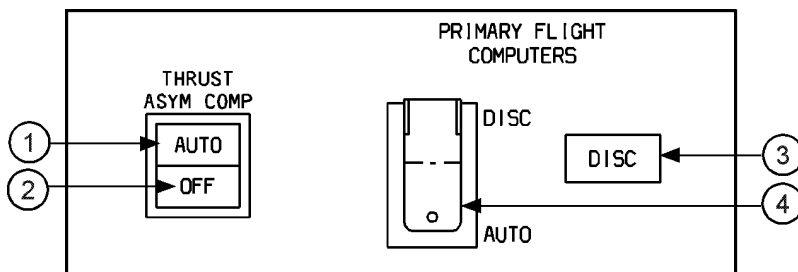
In the secondary mode the expanded indication displays the commanded flap lever position the same as in the primary mode.

In the alternate mode, the position commanded by the flap lever is replaced by flap position index marks at all flap and slat positions, and numbers at flaps 5 and flaps 20. The index marks are used as a guide to position the flaps to the desired setting.

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CONTROLS AND INDICATORS

THRUST ASYMMETRY COMPENSATION AND PRIMARY FLIGHT COMPUTERS CONTROLS



7771406

OVERHEAD PANEL

- ① Thrust Asymmetry Compensation (THRUST ASYM COMP) Switch

AUTO - The thrust asymmetry compensation system operates automatically if a thrust asymmetry condition is detected.

OFF - Disconnects the thrust asymmetry compensation system from the flight control system.
- ② Thrust Asymmetry Compensation OFF Light

Illuminated (amber) - The thrust asymmetry compensation system has been automatically or manually disconnected.
- ③ PRIMARY FLIGHT COMPUTERS Disconnect (DISC) Light

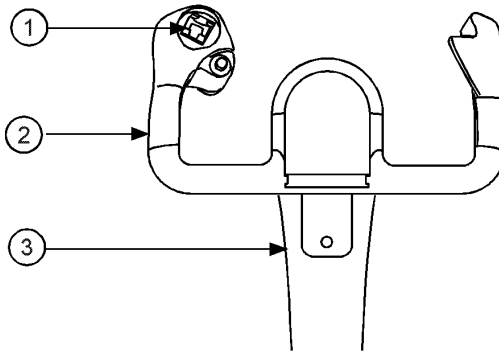
Illuminated (amber) - The primary flight computers are disconnected automatically or manually and the system is in the direct mode.
- ④ PRIMARY FLIGHT COMPUTERS Disconnect Switch

DISC -

 - Disconnects the Primary Flight Computers (PFCs) from the flight control system
 - Puts the flight control system in the direct mode
 - AUTO can be reselected to attempt restoration of secondary or normal mode operation.

AUTO -

 - The flight control system operates in the normal mode
 - System faults automatically cause the system to switch to the secondary or direct modes.

PITCH AND STABILIZER TRIM SYSTEMS**Control Wheel and Column**

7771407

① Pitch Trim Switches

Spring-loaded to neutral.

Push (both switches) -

- In the normal mode in flight, changes the trim reference airspeed
- In the normal mode on the ground, moves the stabilizer
- In the secondary and direct modes, moves the stabilizer.

② Control Wheel

Rotate - Deflects the ailerons, flaperons, and spoilers in the desired direction.

Moves and remains displaced with aileron trim.

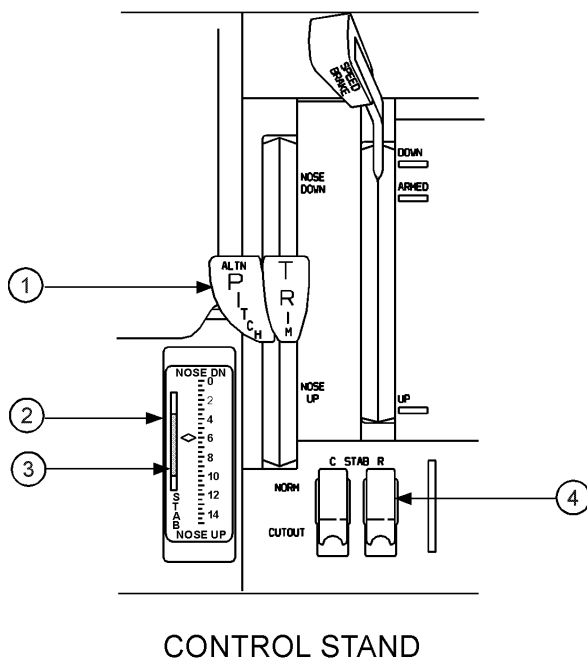
③ Control Column

Push/pull - Commands the airplane to pitch in the desired direction:

- In the normal and secondary modes, deflects the elevator and horizontal stabilizer
- In the direct mode, deflects the elevators.

Does not move with pitch trim operation.

Stabilizer Trim System



7771408

- ① Alternate (ALTN) PITCH TRIM Levers
Spring-loaded to the neutral position.

Push/pull (both levers) -

- In the normal mode, changes trim reference airspeed and moves the stabilizer directly
- In the secondary and direct modes, moves the stabilizer directly.

- ② Stabilizer (STAB) Position Indicator
Indicates stabilizer position in units of trim.

- ③ Takeoff Trim Green Band

The green band indicates the allowable takeoff trim range, based on gross weight, takeoff thrust, and CG information from the FMC. When no information is available, the green band defaults to midrange.

If the stabilizer signal is not present or is invalid, the green band and the pointer are not displayed.

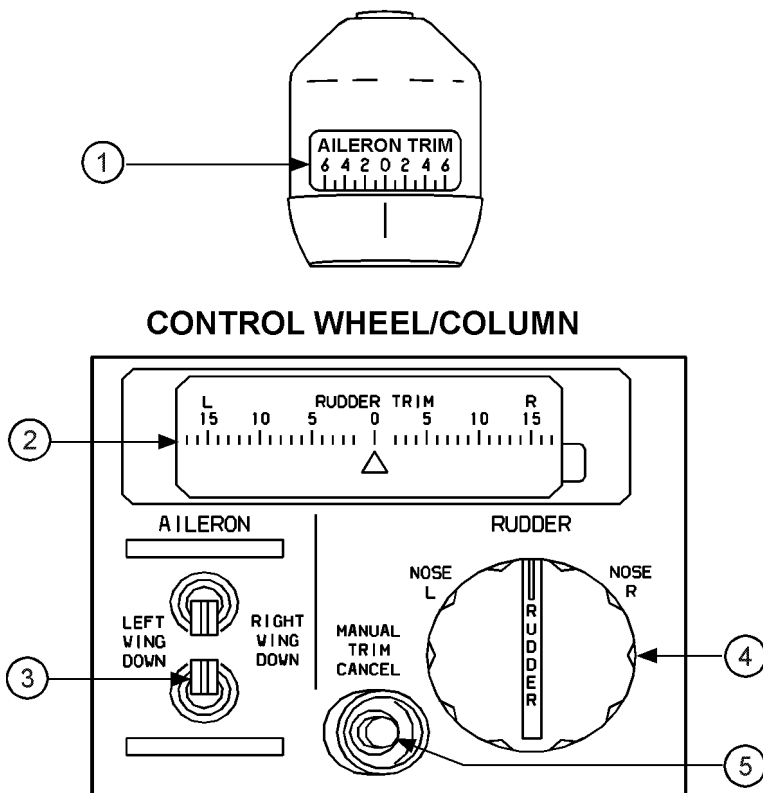
④ Stabilizer (STAB) Cutout Switches

NORM -

- Hydraulic power is supplied to the related stabilizer trim control module
- If unscheduled stabilizer motion is detected, center and/or right system hydraulic power to the related stabilizer trim control module is automatically shut off.

CUTOUT - shuts off the respective center or right hydraulic system power to the related stabilizer trim control module.

AILERON AND RUDDER TRIM CONTROLS



AFT AISLE STAND

7771409

- ① AILERON TRIM Indicator

Indicates units of aileron trim.

- ② RUDDER TRIM Indicator

Indicates units of rudder trim.

- ③ AILERON Trim Switches

Push (both switches) - Moves the control wheel, ailerons, flaperons, and spoilers in the desired direction (spring-loaded to neutral).

④ RUDDER Trim Selector

Spring-loaded to neutral.

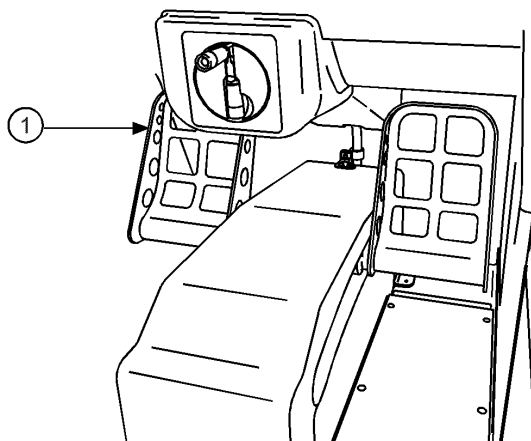
Rotate -

- Trims the rudder in the desired direction
- The trim runs at high speed with the knob rotated past the first left or right detent
- The rudder pedals move with rudder trim operation.

⑤ MANUAL TRIM CANCEL Switch

Push - Cancels manual rudder at high rate.

Rudder/Brake Pedals



7771410

① Rudder Pedals

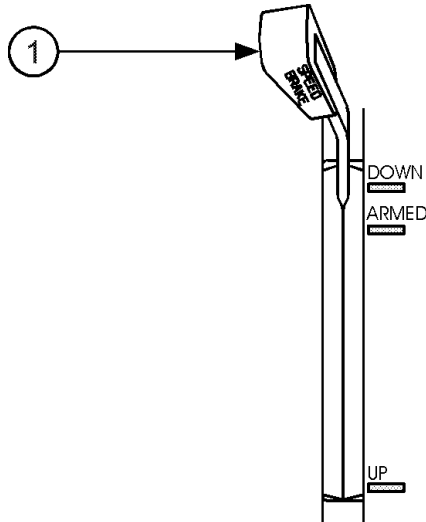
Push - Deflects the rudder in the desired direction.

Refer to Section 6.14, Landing Gear, for brakes and nosewheel steering description.

Speedbrake Lever

On the ground:

- The speedbrake lever moves to DOWN and all spoiler panels retract if either thrust lever is advanced to the takeoff thrust position
- The speedbrake lever moves to UP and all spoiler panels extend if either reverse thrust lever is raised to the reverse idle detent.



CONTROL STAND

7771411

① Speedbrake Lever

DOWN (detent) - All spoiler panels are retracted.

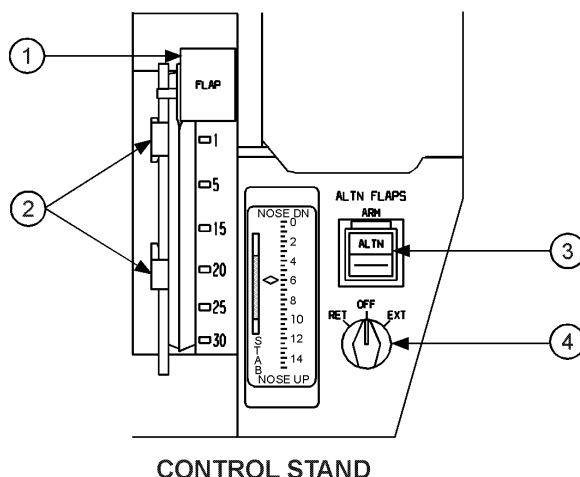
ARMED -

- The auto speedbrake system is armed
- After landing, the speedbrake lever automatically moves to UP and the spoiler panels extend.

UP - the required spoiler panels extend to their maximum in-flight or on-ground position (intermediate positions can be selected).

FLAP SYSTEM

Flap Controls



7771412

① Flap Lever

Primary mode - Positions the slats and flaps hydraulically.

Secondary mode - Positions the slats and/or flaps electrically if hydraulic operation fails.

② Flap Gates

1 - Prevents inadvertent retraction of the slats.

20 - Prevents inadvertent retraction of the flaps past the go-around position.

③ Alternate Flaps Arm (ALTN FLAPS ARM) Switch

Push (ALTN displayed) -

- Arms the alternate flap control mode
- Arms the alternate flaps selector
- Disables primary and secondary flap/slat mode operation
- Asymmetry/skew and uncommanded motion protection, autoslat, and flap/slat load relief are not available
- The flap lever is inoperative.

④ Alternate Flaps Selector

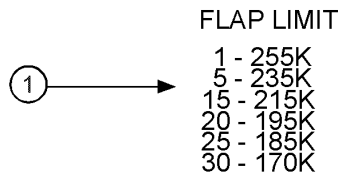
RET - The slats and flaps are electrically retracted.

OFF - Alternate flaps are deactivated.

EXT -

- The slats and flaps are electrically extended
- Maximum extension is flaps 20, with the slats at the midrange (sealed) position.

Flap Limit Placard



CENTER FORWARD PANEL

7771413

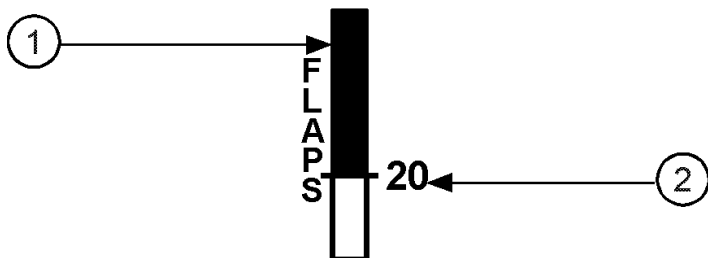
① Flap Limit Placard

Flaps extended speed limits.

Normal Flap Position Indication

Displays combined flap and slat positions when all surfaces are operating normally and control is in the primary (hydraulic) mode. The indicator shows continuous motion.

The indication is no longer displayed 10 seconds after slat retraction.



EICAS DISPLAY

7771414

① Flap Position (white)

UP - The slats and flaps are retracted.

1 - The slats extend to the midrange (sealed) position.

5, 15, and 20 -

- The slats remain in the midrange (sealed) position
- The flaps extend to the commanded position.

25 - The slats extend to the down (gapped) position. The flaps extend to 25.

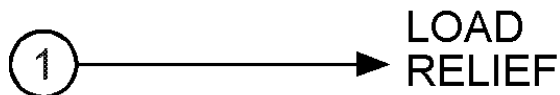
30 - The flaps extend to 30.

② Flap Lever Position (line and number)

Magenta - The slats or flaps are in transit to the commanded position.

Green - The slats and flaps are in the commanded position.

The line and number change color.

Flap Load Relief Indication**EICAS DISPLAY**

7771415

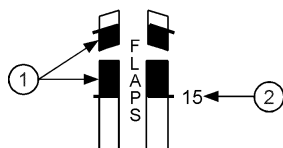
① Flap LOAD RELIEF Indication

Displayed (white) - Flap load relief is retracting the flaps, or inhibiting extension, as required to prevent air load damage due to excessive airspeed.

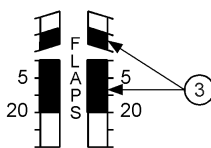
Expanded Flap and Slat Position Indication

If any flap/slat is non-normal or if control is in the secondary mode, slat and flap positions are shown independently. Each wing is also shown separately.

Indicator motion is continuous between flap detents.



SECONDARY DISPLAY



ALTERNATE DISPLAY

EICAS DISPLAY

7771416

① Expanded Flap and Slat Position Indications

The slat indication fills up (forward) for extension.

The flap indication fills down (aft) for extension.

Indication colors of outline and fill are:

- White when operating in secondary mode
- Amber when the respective **FLAPS DRIVE** or **SLATS DRIVE** EICAS message is displayed.

Loss of position information is shown as a white outline with no fill and no flap lever position indication.

② Flap Lever Position (line and number)

Magenta - The slats or flaps are in transit to the commanded position.

Green - The slats or flaps are in the commanded position.

The numbers are shown next to the flap position indicator only.

③ Alternate Flap and Slat Position Indications (white)

Slat and flap extension is limited to slats mid-range (sealed) and flaps 20.

Displayed automatically when the alternate control mode is armed.

Slats - Displays the position of the slats.

Flaps - Displays the position of the flaps.

Flap position index marks - Reference flaps 5 and 20.

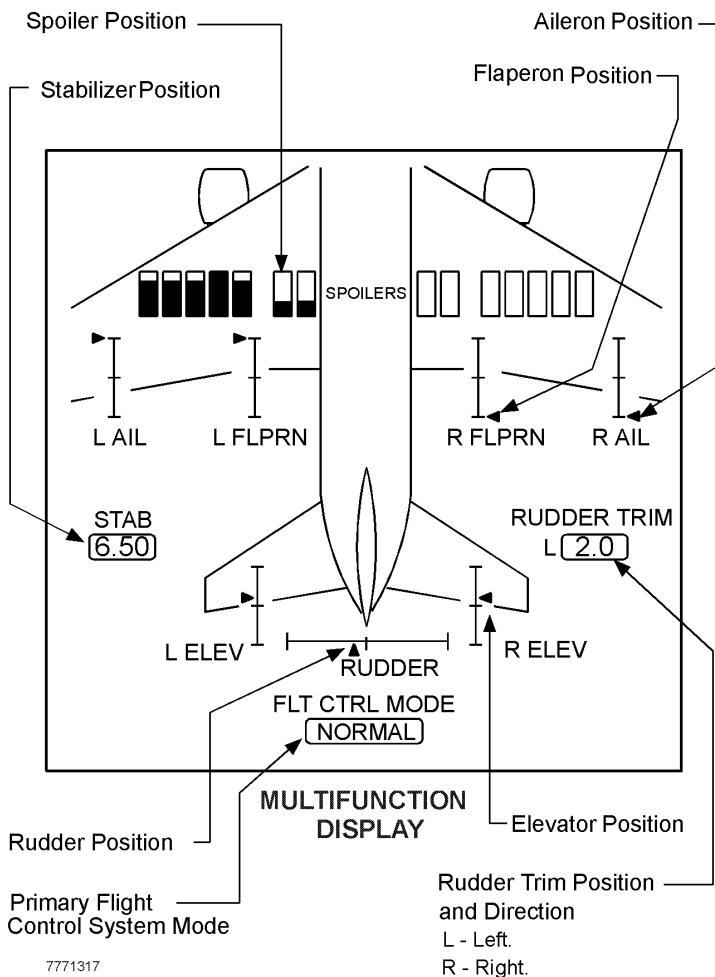
Loss of position information is indicated as a white outline with no fill and no position index marks or numbers.

FLIGHT CONTROL SYNOPTIC DISPLAYS

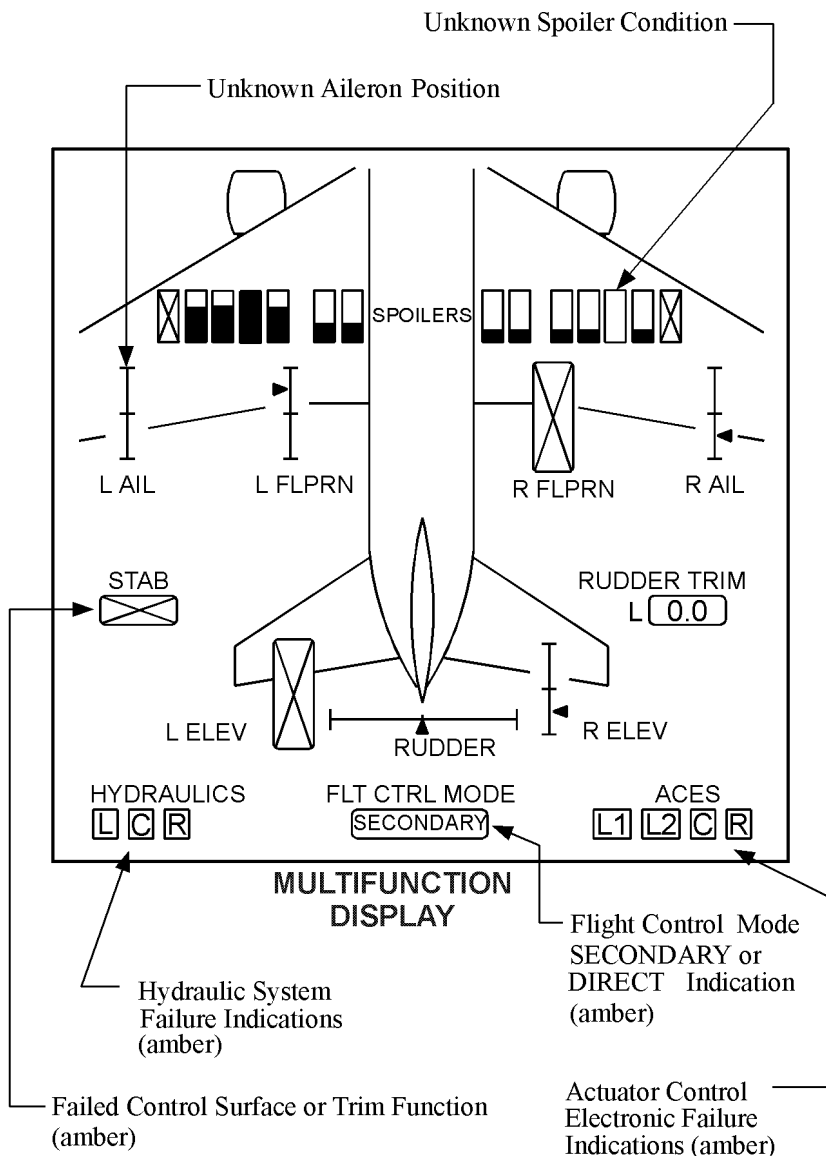
The flight control synoptic is displayed by pushing the FCTL synoptic display switch on the display select panel. Display select panel operation is described in Section 6.10, Flight Instruments, Displays.

Normal Flight Control Synoptic

The following display depicts the proper indication for full control wheel deflection (left).



Non-Normal Flight Control Synoptic



FLIGHT CONTROL SYSTEM EICAS MESSAGES

Note: Configuration (**CONFIG**) warning messages are described in Section 6.15, Warning Systems.

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
AUTO SPEEDBRAKE	Advisory	Siren	A fault is detected in the automatic speedbrake system.
CONFIG FLAPS	Warning	Siren	Flaps are not in a takeoff position when either engine's thrust is in the takeoff range on the ground.
CONFIG RUDDER	Warning	Siren	Rudder trim is not centered when either engine's thrust is in the takeoff range on the ground.
CONFIG SPOILERS	Warning	Siren	Speedbrake lever is not DOWN when either engine's thrust is in the takeoff range on the ground.
CONFIG STABILIZER	Warning	Siren	Stabilizer is not within the greenband when either engine's thrust is in the takeoff range on the ground.
FLAPS DRIVE	Caution	Beeper	Flap drive mechanism has failed.
FLAPS PRIMARY FAIL	Caution	Beeper	Flaps are operating in the secondary mode.
FLAP/SLAT CONTROL	Caution	Beeper	Flap/slat electronics units are inoperative.
FLIGHT CONTROL MODE	Caution	Beeper	Flight control system is operating in the secondary mode.
FLIGHT CONTROLS	Caution	Beeper	Multiple flight control surfaces are inoperative or other flight control system faults are detected.
FLT CONTROL VALVE	Advisory		One or more flight control valves are failed closed or one or more flight control shutoff switches are SHUTOFF.

Message	Level	Aural	Condition
PITCH DOWN AUTHORITY	Caution	Beeper	Pitch down authority is limited.
PITCH UP AUTHORITY	Caution	Beeper	Pitch up and flare authority is limited.
PRI FLIGHT COMPUTERS	Caution	Beeper	Flight control system is operating in the direct mode.
SLATS DRIVE	Caution	Beeper	Slat drive mechanism has failed.
SLATS PRIMARY FAIL	Caution	Beeper	Slats are operating in the secondary mode.
SPEEDBRAKE ARMED	Memo		Speedbrakes are armed.
SPEEDBRAKE EXTENDED	Caution	Beeper	Speedbrake is extended when radio altitude is between 15 feet and 800 feet, or when the flap lever is in a landing position, or when either thrust lever is not closed.
SPOILERS	Advisory		One or more spoiler pairs are inoperative.
STAB GREENBAND	Advisory		Nose gear pressure switch disagrees with computed stabilizer greenband.
STABILIZER	Warning	Siren	Uncommanded stabilizer motion is detected or stabilizer is inoperative.
STABILIZER C	Advisory		Center stabilizer control path is inoperative.
STABILIZER CUTOUT	Advisory		Both stabilizer cutout switches are in CUTOUT.
STABILIZER R	Advisory		Right stabilizer control path is inoperative.
THRUST ASYM COMP	Advisory		Thrust asymmetry compensation is inoperative.

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LIST OF EFFECTIVE PAGES

PAGE	DATE	PAGE	DATE	PAGE	DATE
TOC-1	11/01/00	31	11/01/00		
TOC-2	11/01/00	32	11/01/00		
		33	11/01/00		
1	11/01/00	34	11/01/00		
2	11/01/00	35	11/01/00		
3	11/01/00	36	11/01/00		
4	11/01/00	37	11/01/00		
5	11/01/00	* 38	11/01/01		
6	11/01/00	39	11/01/00		
7	11/01/00	* 40	11/01/01		
8	11/01/00				
9	11/01/00	* 41	11/01/01		
10	11/01/00	42	11/01/00		
11	11/01/00	* LEP-1	11/01/01		
12	11/01/00	* LEP-2	11/01/01		
13	11/01/00				
* 14	11/01/01				
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29	11/01/00				
30	11/01/00				

* Asterisk indicates page(s) revised or added by the current revision.

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FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

INTRODUCTION

The flight instruments and displays supply information to the flight crew on six flat panel liquid crystal display units. The units display four primary groups of information:

- The Primary Flight Display (PFD)
- The Navigation Display (ND)
- The Engine Indication And Crew Alerting System (EICAS)
- The Multifunction Display (MFD).

Detailed information on the following subjects is found in other parts of this section:

- PFD
- ND
- Electronic Checklist

DISPLAY SYSTEM CONTROLS

General

During normal operations:

- The inboard display selectors are set to MFD
- PFDs are displayed on the two outboard display units
- NDs are displayed on the two inboard display units
- EICAS is displayed on the upper center display unit
- The lower center display unit defaults to the secondary engine display at power-up. All Display Select Panel (DSP) functions may be displayed on the lower center display unit. (The flight crew should keep the secondary engine display selected if no other display is being used; i.e., status, checklist, etc.)

Inboard Display Selectors

The inboard display selectors are used to select PFD, ND (NAV position), MFD, or EICAS displays on the inboard display units.

The normal position is MFD. With MFD selected, ND information is displayed on the inboard display units if NAV is selected on the display select panel (refer to Display Select Panel in this section).

In the ND, PFD, and EICAS positions, only the selected displays can appear on the inboard display units.

With MFD selected on the inboard display selector, the following ND and EFIS control logic applies:

- If both pilots have an ND on the inboard displays, then each EFIS control panel controls its corresponding ND display
- If there is an ND display on one inboard display unit and on the lower center display unit, then the pilot who does not have an ND on the inboard display unit controls the ND on the lower center display unit
- If neither pilot has an ND display on the inboard display unit, and there is an ND display on the lower center display unit, then the left EFIS control panel controls the lower center display unit
- If both pilots have an ND display on the inboard display unit, and there is an ND on the lower center display unit, then the left EFIS control panel controls the left inboard display unit and the lower center display unit. The ND on the left inboard and the lower center display units are identical.

When an inboard display selector is in the ND or PFD position, new displays selected from the display select panel to that inboard display are inhibited. The annunciator light above the associated display select panel switch is also inhibited.

When an inboard display selector is in the EICAS position, only the ENG, AIR, and FUEL switches can affect the display. Pushing one of those switches causes the display of the respective compacted blocks of information on the EICAS display. The cancel/recall switch operates normally. Refer to these chapters for more information on compact EICAS displays:

- Section 6.2, Air Systems
- Section 6.7, Engines, APU
- Section 6.12, Fuel.

The inboard display selectors have no effect on the inboard displays if an outboard display unit fails; the PFD automatically moves to the inboard display unit regardless of the position of the inboard display selector. Upper center display unit failure automatically switches the EICAS display to the lower center display unit. A subsequent EICAS selection on either of the inboard display selectors brings the EICAS display to that inboard display unit, and assuming no latched condition exists, the lower center display unit initially displays secondary engine instruments. Following this initial display configuration, the lower center display unit can be used in its usual MFD mode.

Display Select Panel

The display select panel controls the MFD format on the left and right inboard display units and the lower center display unit. The selected display is indicated by the illuminated annunciator light on the display select panel (**L INBD, R INBD, LWR CTR**).

After a display unit is selected, the appropriate display is selected (ENG, STAT, ELEC, HYD, FUEL, AIR, DOOR, GEAR, FCTL, CHKL, COMM, or NAV).

A new display selection automatically replaces the previous one. A second selection of the same display for the lower center display unit blanks the display. A second selection of the same display on either inboard display causes display of the ND. If there is more than one page of status messages, pushing STAT pages through the messages.

Pushing the COMM or CHKL switch for either inboard display unit shows the selected display. The cursor automatically appears on the selected display.

Display select panel control is also available through any CDU. This capability is available at all times. Once display select panel control is selected on one CDU, it cannot be selected on the other two CDUs.

When used as an MFD, the lower center display unit and the two inboard display units can display the following displays:

- ND (NAV switch)
- Status page (STAT switch)
- Secondary engine EICAS (ENG switch)
- System synoptics (ELEC, HYD, FUEL AIR, DOOR, GEAR, FCTL switches)
- Communications pages (COMM switch)
- Electronic checklist (CHKL switch).

EFIS Control Panels

The EFIS control panels control display options, mode, and range for the respective PFDs and NDs. Refer to the PFD and ND parts of this section.

If an EFIS control panel fails, the displays can be controlled through the related CDU. This CDU capability is available at all times, but inhibits inputs from the respective EFIS control panel.

Display Brightness Control

The MASTER BRIGHTNESS control provides simultaneous brightness adjustment for all displays and panel lighting. Also, each display unit has an individual control with limited range control when master brightness is on, and full range control when master brightness is off.

Two remote light sensors, located left and right on the top of the glareshield, measure brightness in the forward field of view and adjust the outboard display (PFD) brightness as required. Individual sensors on the front of each display unit also affect display brightness. The CDUs, mode control panel displays, standby flight instruments, and aisle stand panel displays are also controlled by the automatic display brightness control system.

Cursor Control Device (CCD)

The CCDs provide control of the display cursor when an MFD displays communications or checklist pages. For detailed information on the following subjects, refer to:

- Section 6.5, Communications
- Electronic Checklist, this section.

CCD Touch Pad

The CCD uses a touch pad. When touching the pad the touch location coordinates translate to the affected display, moving the cursor to those coordinates on the MFD.

The cursor moves relative to finger movement across the touch pad. Except for the four corners of the touch pad, lifting the finger off the touch pad and touching a different location does not move the cursor. Only finger motion in contact with the touch pad moves the cursor.

Touching a corner immediately places the cursor in the corresponding corner of the MFD. This helps the pilot quickly locate the cursor and speeds access to the selections at the four corners of the checklist or communications display.

CCD Cursor Location Control

Selecting a menu, communications, or checklist function requires the use of the cursor location switches on the CCD.

If a new function is selected on an inboard display that requires a communication, checklist, or maintenance function, then the system automatically selects the respective cursor control device to that display.

If a new function requiring a cursor is selected on the lower center display, then the system automatically selects the CCD not currently being used on an inboard display to the lower center display. If neither cursor is in use, it selects the CCD cursor that was previously displayed on the lower center display. Cursor selection defaults to the left CCD on power-up.

The cursor location light above the switch illuminates to indicate the selected display unit.

Selecting a display where there is no function requiring a cursor has no effect. For example, if the inboard display does not display a communications or checklist page, pushing an INBD cursor location switch has no effect on the selected inboard display.

Only one CCD can access a given display at a time. The last pilot who selects the cursor on the selected MFD has control. The other cursor disappears from the display and the cursor location light on that CCD extinguishes. The cursors are visually different so the pilots know who is currently in control of the cursor on a display.

If both pilots are accessing the same checklist or communications functions on different displays, both are forced to the same page, with that page controlled by the pilot with cursor control.

DISPLAY SOURCE SELECTION

General

The display system automatically reconfigures to compensate for most faults. The instrument display source select panels provide manual switches for the pilots to use if certain faults are not corrected automatically.

Instrument source select switches provide alternate information sources for the PFDs and NDs. These switches provide automatic source selection when in the off position (switch out, with the **ALTN** and **CDU** switch annunciations not visible).

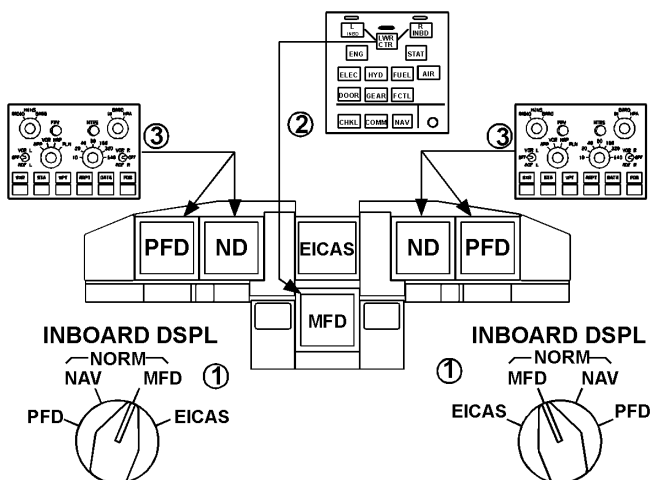
If there is an undetected source failure (a display is missing or parts of a display appear faulty), the non-normal (**ALTN** or **CDU**) position provides the capability for manual selection of PFD and ND sources.

Undetected display source failures, such as missing / faulty display information or intermittent display blanking, may not result in automatic switching. The **CDU** position of the NAV switch or the **ALTN** position of the **DSPL CTRL** or **AIR DATA/ATT** switches provide the capability to manually select PFD and ND sources.

A center display control source switch is provided for the center displays. Examples of display selections follow.

Normal Display Configuration

- ① The INBOARD DISPLAY selectors are set to MFD.
- ② The lower center display unit is the preferred MFD controlled by the display select panel.
- ③ The outboard display units display PFDs and the inboard display units display NDs. The related EFIS control panel controls what is on the PFD and ND.



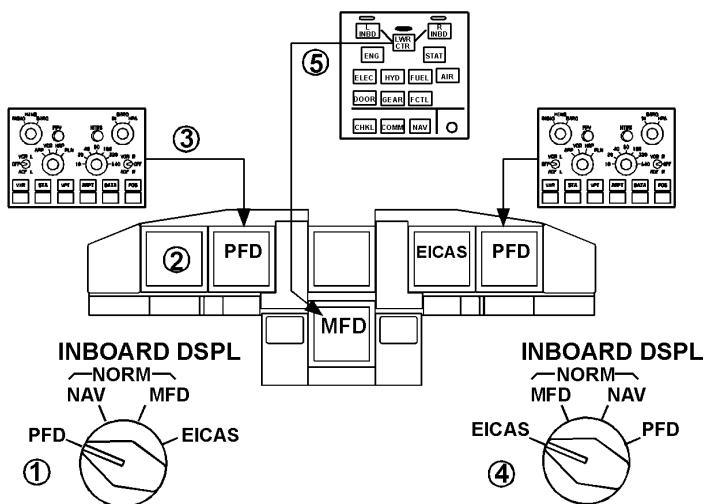
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Inboard Display Switching

- ① The left INBOARD DISPLAY selector is set to PFD. With an INBOARD DISPLAY selector in any position other than MFD, the selector position alone determines what is displayed on the display unit. The left inboard display cannot display any selections made on the display select panel.
- ② The left outboard display blanks and the PFD moves to the left inboard display unit.
- ③ The left EFIS control panel controls the PFD.
- ④ The right INBOARD DISPLAY selector is set to EICAS.

The right inboard display cannot display selections made on the display select panel, except for compact engine, air and fuel synoptics, and the CANCEL/RECALL switch functions.

- ⑤ The upper center display blanks and the EICAS display moves to the right inboard display unit. Now there is no ND visible. Either pilot could use the display select panel to display an ND on the lower center display unit (refer to the following pages).

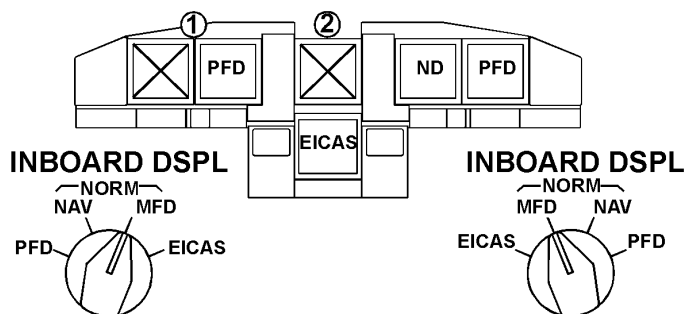


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Display Unit Failure Automatic Switching

- ① If an outboard display unit fails, the PFD automatically moves to the inboard display unit. The INBOARD DISPLAY selector and the display select panel no longer have any control over that inboard display unit.
- ② If the upper center display unit fails, the EICAS display automatically moves to the lower center display unit.

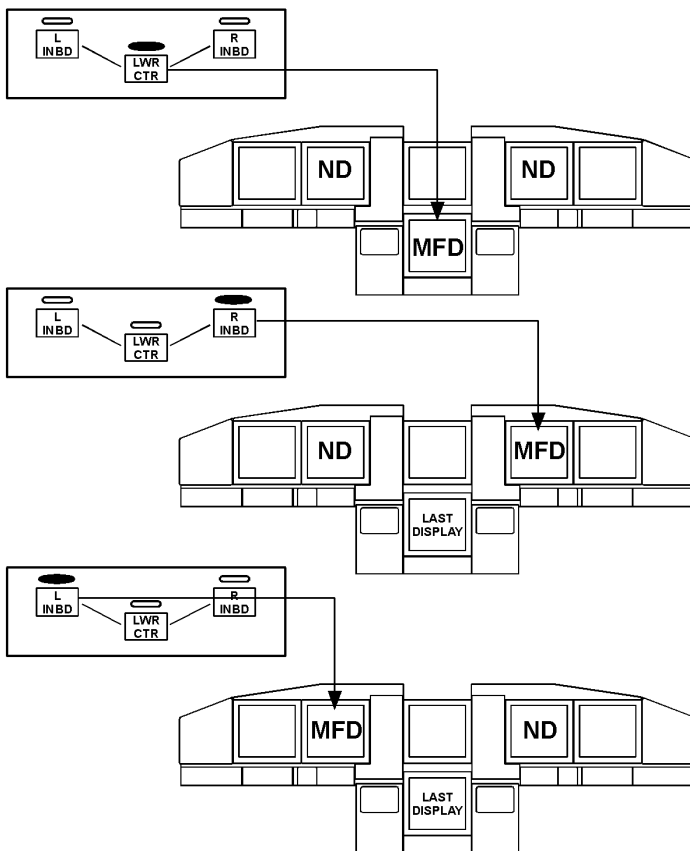
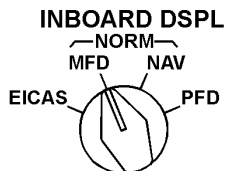
Pushing the ENG display switch switches EICAS between primary and compacted modes if no pop-up condition is active. The display select panel can still display compacted engine, air and fuel synoptics. The CANCEL/RECALL switch operates normally.



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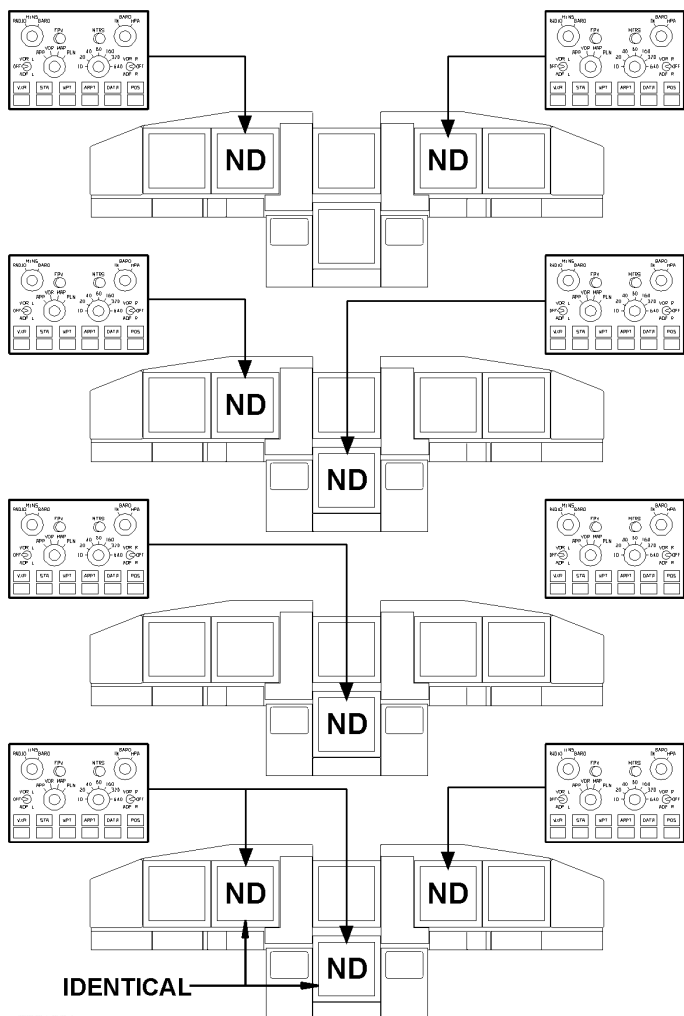
Display Select Panel MFD Selection

With the INBOARD DISPLAY selectors set to MFD, the display select panel display switches are used to designate a display as an MFD. The designated display (L INBD, LWR CTR, or R INBD) is then controlled by the other display select panel selections (ENG, STAT, CHKL, COMM, NAV, or one of the system synoptics).



EFIS Control Panel Multiple ND Control

This shows which EFIS control panel controls which ND when multiple NDs are displayed, or when the ND is displayed on the lower center display unit.



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DISPLAY SYSTEM INFORMATION SOURCE

Air Data Inertial Reference System (ADIRS)

The ADIRS provides:

- Primary, secondary and standby air data
- Inertial reference information.

The major components of the ADIRS are:

- One Air Data Inertial Reference Unit (ADIRU)
- One Secondary Attitude Air Data Reference Unit (SAARU)
- Eight air data modules
- Six static ports
- Three pitot probes
- Two angle-of-attack vanes
- One total air temperature probe.

Air Data Inertial Reference Unit (ADIRU)

The ADIRU is the primary source for speed, altitude, attitude and inertial navigation position information. The ADIRU processes information measured by its internal gyros and accelerometers, and from air data module inputs, angle-of-attack vanes and other systems.

The ADIRU is described in Section 6.11, Flight Management, Navigation.

Secondary Attitude Air Data Reference Unit (SAARU)

The SAARU is the secondary source for speed, altitude, and attitude information. The SAARU processes information measured by its internal gyros and accelerometers, and from air data module inputs, angle-of-attack vanes, and other systems.

The SAARU also transmits roll and pitch attitude information to the standby attitude display.

The SAARU does not provide navigational position data. The SAARU is described in Section 6.11, Flight Management, Navigation.

Air Data

Three static ports are located on the left side of the airplane and three static ports are located on the right side of the airplane. Left and right static ports are paired through pneumatic tubing to each of the left, center and right air data modules. The air data modules convert static air pressure to a digital output for use by other systems. The center static ports are also connected to an independent air data module to provide static pressure to the standby airspeed indicator and the standby altimeter.

Two pitot probes (right and center) are mounted on the right forward section of the airplane. One pitot probe (left) is mounted on the left forward section of the airplane. An air data module is connected to each pitot probe. These air data modules convert dynamic air pressure to a digital output for use by other systems. The center pitot probe also provides dynamic pressure to the standby air data module.

Angle-of-Attack

There are two angle-of-attack vanes, one located on each side of the forward fuselage. The vanes measure airplane angle-of-attack relative to the air mass.

Total Air Temperature

A total air temperature probe is mounted outside the airplane to sense air mass temperature. The temperature sensed by the probe is used by the ADIRU and the SAARU to compute total air temperature.

Static Air Temperature

Static air temperature, displayed on the CDU PROGRESS page, comes from the ADIRU, using total air temperature probe information. In the event the ADIRU value is invalid, the SAARU computed value is displayed.

PRIMARY FLIGHT DISPLAY (PFD)

Introduction

The PFDs present a dynamic color display of all the parameters necessary for flight path control. The PFDs provide the following information:

- Flight mode annunciation
- Airspeed
- Altitude
- Vertical speed
- Attitude
- Steering information
- Radio altitude
- Instrument landing system display
- Approach minimums
- Heading/track indications
- Time critical warnings.

Failure flags are displayed for airplane system failures. Displayed information is removed or replaced by dashes if no valid information is available to the display system (because of out-of-range or malfunctioning navigation aids). Displays are removed when a source fails or when no system source information is available.

PFD Information

Flight mode annunciations are described in Section 6.4, Automatic Flight.

Airspeed

Airspeed is displayed on a tape and in a digital window on the left side of the PFD. The current Mach number is digitally displayed below the airspeed tape when the current Mach number is greater than 0.40. An airspeed trend vector indicates predicted airspeed in 10 seconds. Selected airspeed is displayed above the airspeed tape.

Takeoff and landing reference speeds and flap maneuvering speeds are shown along the right edge of the airspeed tape. Maximum and minimum airspeeds are also displayed along the right edge of the airspeed tape.

Altitude

Altitude is displayed on an altitude tape along the right side of the PFD. It is also shown digitally in a window in the middle of the tape. When METERS is selected on the EFIS control panel:

- Current altitude in meters is also shown above the altitude window
- Selected altitude in meters is displayed above the altitude tape.

Selected altitude is displayed above the altitude tape and is boxed when approaching the selected altitude. Selected altitude is also depicted with a bug on the altitude tape.

The selected barometric approach minimum is indicated on the altitude tape with a triangular pointer and a line when BARO minimums are selected. When RADIO minimums are selected, the pointer is still set at BARO minimums; there is no line.

A landing altitude reference bar is displayed along the inner edge of the altitude indication. The reference bar indicates the height above touchdown. A white bar is displayed from 1000 to 500 feet above landing altitude. An amber bar is displayed from 500 feet to the landing altitude.

The current barometric reference is displayed below the altitude tape. A pre-selected barometric reference can be displayed when STD is displayed.

Landing reference is selectable between QNH and QFE on the APPROACH REF page of the FMC. QNH is the normal operating mode. Selecting QFE sets the destination landing altitude indication to zero altitude. With the landing reference set to QFE, changing the barometric setting from STD to QFE changes the PFD altitude tape background color to green. With QFE selected and climb mode active, changing the barometric setting from QFE to STD causes the landing reference to toggle from QFE to QNH and the altitude tape background color changing from green back to normal. A description of QFE operation is contained in the Landing Reference description in Section 6.11, Flight Management, Navigation.

Vertical Speed

Vertical speed is displayed to the right of the altitude tape with a tape and pointer. Vertical speed is digitally displayed above or below the vertical speed display when vertical speed is greater than 400 feet per minute. It is displayed above with positive vertical speed and below with negative vertical speed. The selected vertical speed bug shows the selected vertical speed when in the AFDS vertical speed (V/S) pitch mode.

Attitude

The attitude indication displays the airplane pitch and roll attitude referenced to the horizon.

Pitch attitude is displayed by an airplane symbol against a pitch scale. The pitch scale is in 2.5° increments.

A pointer indicates bank angle in increments of 10, 20, and 30 degrees. Single marks indicate 45 and 60 degrees of bank. A small rectangle under the bank angle pointer indicates slip and skid conditions. Bank angle is also represented by the attitude of the airplane symbol against the horizon line and pitch scale.

A pitch limit indication is displayed at low speeds when the flaps are up and at all times when the flaps are down.

Steering Indications

The flight director steering indications are displayed when the associated flight director switch is on.

TCAS resolution advisories are displayed in the attitude indication area. Refer to Section 6.15, Warnings.

The Flight Path Vector (FPV) symbol represents airplane flight path angle vertically and drift angle laterally. The flight path vector is displayed on the PFD when the EFIS control panel FPV switch is selected on, or the MCP FPA reference switch is selected on.

The Flight Path Angle (FPA) symbol shows the selected flight path angle when the MCP FPA reference switch is selected on and either the flight director or autopilot is engaged.

The FPV and FPA symbols are displayed in two sizes and brightness levels. The large, bright FPV/FPA symbols are displayed when the previously stated selections are made and the flight director is off. The small, dim FPV/FPA symbols are displayed when the previously stated selections are made and the flight director is displayed.

Radio Altitude

The current radio altitude is displayed in the bottom center of the attitude indication area when radio altitude is below 2,500 feet AGL.

Instrument Landing System Indications

ILS glide slope and localizer deviation, frequency / identification, DME, course, and marker beacon indications are provided.

The approach reference information appears above and to the left of the attitude display. The ILS station identification or frequency, course, and (if available) DME are displayed.

The marker beacon indication (OM - outer marker, IM - inner marker, or MM - middle marker) is displayed in the upper right corner of the attitude display area.

The glideslope pointer and scale appear on the right side of the attitude indication.

The localizer pointer and scale appear at the bottom of the attitude indication.

Below 2500 feet radio altitude, with the localizer pointer in view, a rising runway symbol comes into view. The symbol provides lateral guidance. At 200 feet radio altitude, the symbol rises toward the airplane symbol.

Approach Minimums

The selected radio altitude or barometric approach minimums set on the EFIS control panel is displayed near the bottom left of the altitude display.

Heading/Track Indications

Selected heading/track information is displayed in the bottom section of the PFD on a section of the compass rose. Current heading is displayed under a pointer at the top of the compass rose. The MCP selected heading bug is displayed on the outside of the compass rose. The MCP selected track bug is displayed on the inside of the compass rose.

Heading or track is displayed based on the position of the MCP HDG/TRK reference switch. The selected heading or selected track is annunciated in the left half of the compass rose. The current heading/track reference (MAG/TRU) is shown in the right half of the compass rose. A line drawn perpendicular to the edge of the compass rose from the invisible center depicts the current airplane track.

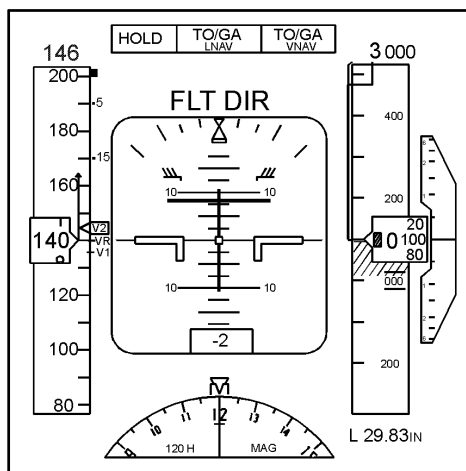
Time Critical Warnings

Time critical warnings are displayed in large capital letters between the attitude display and the heading/track compass rose. Refer to Section 6.15, Warnings.

Typical PFD Displays

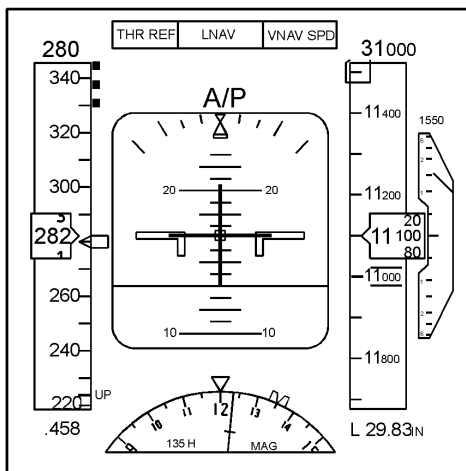
Typical PFD configurations for six phases of flight follow. The autopilot, LNAV, and VNAV are engaged for climb, cruise, descent, approach, and landing. The AFDS approach mode is used for approach and landing.

PFD Takeoff Display



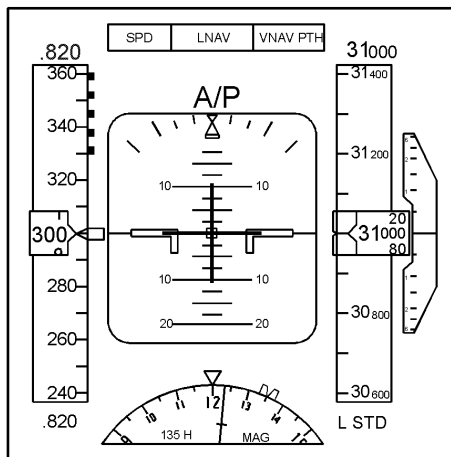
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PFD Climb Display

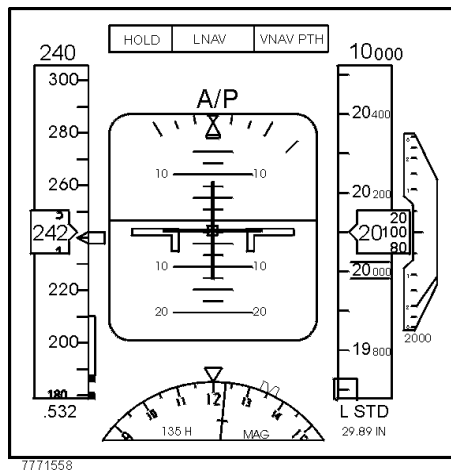


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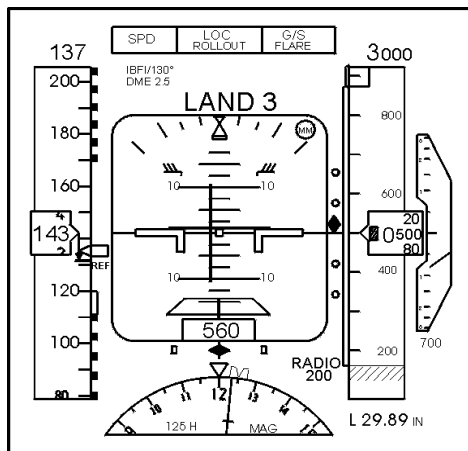
PFD Cruise Display



PFD Descent Display

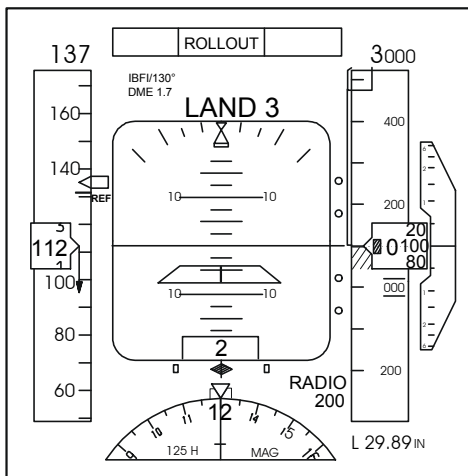


PFD Approach Display



7771559

PFD Landing Display



7771560

NAVIGATION DISPLAY (ND)

Introduction

The NDs provide a mode-selectable color flight progress display. The modes are:

- MAP
- VOR
- APP (approach)
- PLN (plan).

The MAP, VOR, and APP modes can be switched between an expanded mode with a partial compass rose and a centered mode with a full compass rose.

ND Modes

Map Mode

The MAP mode is recommended for most phases of flight.

Presented track up, this mode shows airplane position relative to the route of flight against a moving map background.

Displayed information can include:

- Selected and current track
- Selected and current heading
- Position trend vector
- Range to selected altitude
- Map range scale
- Ground speed
- True airspeed
- Wind direction and speed
- Next waypoint distance
- Waypoint estimated time of arrival
- Selected navigation data points.

Additional Navigation Facility (STA), Waypoint (WPT), Airport (ARPT), Route Progress (DATA) and Position (POS) data are available for display on the ND in both the expanded and center map modes.

VOR and Approach Modes

The VOR and APP modes are presented heading up. The VOR and APP modes display track, heading, and wind speed and direction with VOR navigation or ILS approach information.

Plan Mode

The PLN mode is presented true north up. The active route may be viewed using the **STEP** prompt on the CDU LEGS pages.

ND Information

Heading

Heading is supplied by the FMC or Air Data Inertial Reference System (ADIRS). The ND compass rose can be referenced to magnetic north or true north. The heading reference switch is used to manually select magnetic or true reference. The compass display is automatically referenced to true north when the airplane is north of 82° north or south of 82° south latitude, or near the magnetic poles with the heading reference switch in NORM.

Track

Track is supplied by the FMC during normal operation and by the CDU when in alternate navigation.

Traffic

Traffic information from the TCAS can be displayed on the ND. TCAS is described in Section 6.15, Warning Systems.

Weather Radar

Weather radar information can be displayed on the ND. The weather radar system is described in Section 6.15, Warning Systems.

Failure Flags and Messages

Failure flags are displayed for system failures or invalid information. Indications are removed or replaced by dashes when source system information is not available.

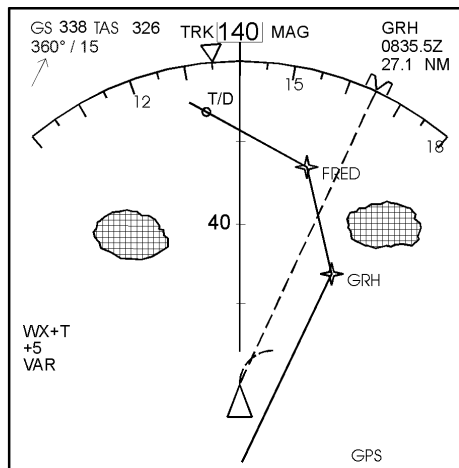
The message **EXCESS DATA** is displayed if the amount of information sent to the ND exceeds the display capability. When this occurs, the primary display system removes information from the center of the display outward; information near the outer selected range area is still displayed. The message can be removed by:

- Reducing the amount of map information,
- Reducing range, or
- Deselecting one or more of the EFIS control panel map switches (STA, WPT, ARPT, DATA, POS).

Typical ND Map Displays

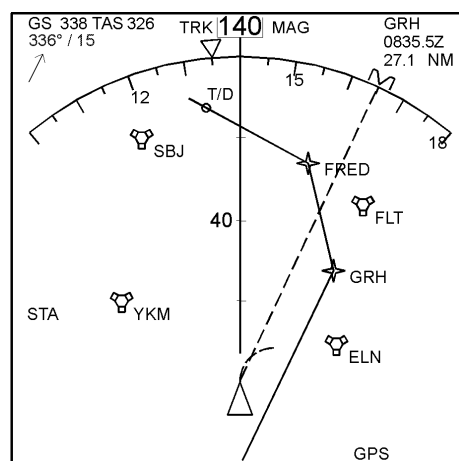
Typical ND map displays are shown on the following pages. Examples of other ND displays (centered map, approach, VOR, and plan modes) are shown in parts of this section.

WXR
(weather
radar) map
switch
selected.



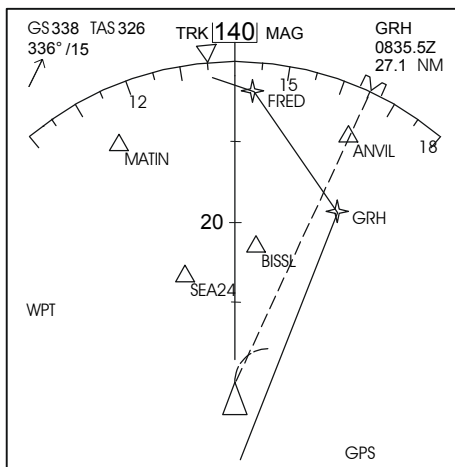
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STA
(station)
map switch
selected.

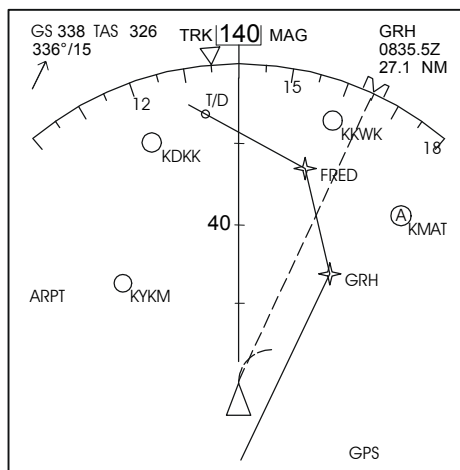


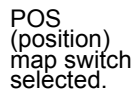
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WPT
(waypoint)
map switch
selected.



ARPT
(airport)
map switch
selected.





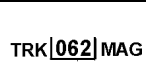
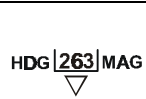

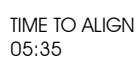

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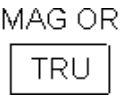



ND Symbolology

The following symbols can be displayed on each ND, depending on EFIS control panel switch selections. Colors indicate the following:

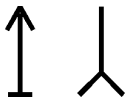

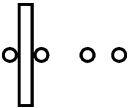

- W (white) - Present status, range scales
- G (green) - Dynamic conditions
- M (magenta or pink) – Command information, pointers, symbols, fly-to condition
- B (blue or cyan) – Non-active or background information
- A (amber or yellow) – Cautions, faults, flags
- R (red) – Warnings



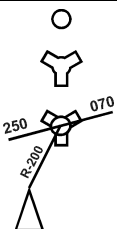
General

Symbol	Name	ND Mode	Remarks
	Track-up ND. Track orientation (G), current track (W), and track reference (G)	Shows track in MAP, MAP CTR	Displays TRK as the orientation, the current track, and MAG or TRU as the reference, and points to the heading on the compass rose.
	Heading-up ND. Heading orientation (G), current heading (W), heading reference (G), and heading pointer (W)	Shows HDG (heading) in VOR, VOR CTR, APP, APP CTR	Displays HDG as the display orientation, current heading, MAG or TRU as the heading reference, and points to the heading on the compass rose.
	Grid heading (W)	MAP, MAP CTR, PLAN	Displays above 70 degrees latitude.
	ADIRU time to align (W)	All	Indicates time remaining for IRU alignment. Replaces wind direction / speed and wind arrow, on the ground, during alignment.
	Selected heading bug (M)	All except PLAN	Displays the MCP-selected heading. A dashed line (M) may extend from the marker to the airplane symbol. In the MAP mode with LNAV, LOC, or ROLLOUT engaged, the dashed line is removed 10 seconds after the selected heading bug is moved.

	Selected track bug (M)	All except PLAN	Displays the MCP-selected track. A dashed line (M) may extend from the marker to the airplane symbol.
	Track line and range scale (W)	MAP, MAP CTR, VOR, VOR CTR, APP, APP CTR	Indicates current track. Number indicates half the range (VOR CTR and APP CTR do not display range).
	Heading/track reference (G) box (W) in TRU, box (A) if TRU displayed in descent	All except PLAN	Indicates heading/track is referenced to magnetic north or true north. Switching from TRU to MAG displays a box around MAG for 10 seconds.
	Expanded compass (W)	MAP, APP, VOR	Displays 90 degrees of compass rose.
	Current heading pointer (W)	MAP, MAP CTR	Points to current heading on the compass rose.
GS310	Groundspeed (W)	All	Current ground speed.
TAS312	True airspeed (W)	All	Current true airspeed displayed above 100 knots.
	Wind direction/speed and wind arrow (W)	All	Indicates wind bearing, speed, and direction, with respect to display orientation and heading/track reference. Arrow not displayed in the PLAN map mode.





Radio Navigation



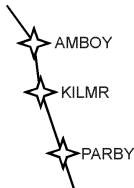
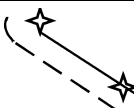
Symbol	Name	ND Mode	Remarks
VOR L, R ILS L, C, R	Reference receiver (G)	VOR, VOR CTR, APP, APP CTR	Indicates the selected receiver as the display reference.
116.80 OR SEA	ILS (W)/VOR (W) Reference receiver frequency or identifier display	VOR, VOR CTR, APP, APP CTR	Frequency displayed before the identifier is decoded. The decoded identifier replaces the frequency. Medium size characters for VOR, small size characters for DME only.
DME 24.6	DME distance (W)	VOR, VOR CTR, APP, APP CTR	Indicates DME distance to the reference navaid.
CRS 135	Reference ILS or VOR course (W)	VOR, VOR CTR, APP, APP CTR	Indicates the VOR course or ILS localizer course.
	Left VOR (G) or ADF (B) pointer head and tail	All except PLAN	Indicates bearing to (head) or from (tail) the tuned station, if selected on the respective EFIS control panel.
	Right VOR (G) or ADF (B) pointer head and tail		
	ILS localizer or VOR course deviation indication (M) and scale (W)	VOR, VOR CTR, APP, APP CTR	Displays LOC or VOR course deviation. Deviation indicator points in direction of VOR or ILS selected course. For ILS deviation, indicator fills (M) when less than 2 1/2 dots from center.
	Selected course pointer (W) and line (M)	VOR, VOR CTR, APP, APP CTR	Displays CDU-selected course.


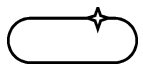


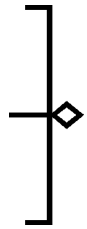
	Glide slope pointer (M) and scale (W)	APP, APP CTR	Displays glideslope position and deviation. Deviation indicator fills (M) when less than 2 1/2 dots from center.
	To/from indication (W)	VOR CTR	Located near airplane symbol. Displays VOR TO/FROM indication.
TO FROM	To/from indication (W)	VOR, VOR CTR	Displays VOR to/from indication.
	VOR (B, G), DME/TACAN (B, G), VORTAC (B, G)	MAP, MAP CTR	When the EFIS control panel STA map switch is selected on, appropriate nav aids are displayed (B). Tuned VHF nav aids are displayed in green, regardless of switch selection. When a nav aid is manually tuned, the selected course and reciprocal are displayed.
	VOR/DME raw data radial and distance (G)		When the POS map switch is selected on, the station radial extends to the airplane.
VOR L, R ADF L, R	VOR (G) or ADF (B) selection	MAP, MAP CTR, VOR, VOR CTR, APP, APP CTR	Located lower left or right corner. Represents positions of the EFIS control panel VOR/ADF switches.
116.80 OR SEA OR 520 OR BF	VOR frequency or identifier (G), ADF frequency or identifier (B)	MAP, MAP CTR, VOR, VOR CTR, APP, APP CTR	Frequency is displayed before identifier is decoded. Decoded identifier replaces the frequency. For VORs, small size characters indicate only DME information is being received.






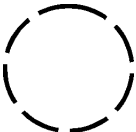

DME 24.6	DME distance (G)	MAP, MAP CTR, VOR, VOR CTR, APP, APP CTR	Indicates DME distance to the referenced navaid.
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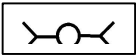
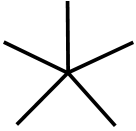
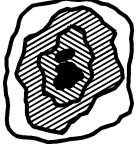

Map

Symbol	Name	ND Mode	Remarks
	Airplane symbol (W)	MAP, MAP CTR, VOR, APP	Current airplane position is at the apex of the triangle.
	Airplane symbol (W)	VOR CTR, APP CTR	Current airplane position is at the center of the symbol.
	Position trend vector (W) (dashed line)	MAP, MAP CTR	<p>Predicts position at the end of 30, 60, and 90 second intervals. Each segment represents 30 seconds. Based on bank angle and ground speed. Selected range determines the number of segments displayed. For range:</p> <ul style="list-style-type: none"> • greater than 20 NM, 3 segments • = 20 NM, 2 segments • = 10 NM, 1 segment.
	Airplane symbol (W)	PLAN	<p>Indicates actual position and track along the flight plan route in plan mode only.</p> <p>Inhibited north of 82°N latitude and south of 82°S latitude.</p>
ABCDE	Active waypoint identifier (M)	MAP, MAP CTR, PLAN	Indicates the active flight plan waypoint, the next waypoint on the route of flight.





124 NM	Active waypoint distance (W)	MAP, MAP CTR, PLAN	Distance to the active waypoint.
0025 TTG	Active waypoint time to go during alternate navigation(W)	MAP, MAP CTR, PLAN	Indicates CDU calculated time to go in hours and minutes to active waypoint during alternate navigation.
0835.4z	Active waypoint ETA (W)	MAP, MAP CTR, PLAN	Indicates ETA at the active waypoint. Time is based on distance to go and ground speed. It does not consider FMC performance predictions and may differ from other FMC ETAs that do.
 AMBOY	Waypoint: active (M), inactive (W)	MAP, MAP CTR, PLAN	Active - represents the waypoint the airplane is currently navigating to. Inactive - represents the waypoints on the active route.
 MLF	Off route waypoint (B)	MAP, MAP CTR	When the EFIS control panel WPT map switch is selected on, waypoints not on the selected route are displayed, in ND ranges of 10, 20, or 40.
	Flight plan route: active (M), modified (W), inactive (B)	MAP, MAP CTR, PLAN	The active route is displayed with a continuous line (M) between waypoints. Active route modifications are displayed with short dashes (W) between waypoints. Inactive routes are displayed with long dashes (B) between waypoints.
	Offset path and identifier: active route (M), modified route (W)	MAP, MAP CTR, PLAN	Presents a dashed line parallel to and offset from the active or modified route.

	Route data: active waypoint (M), inactive waypoint (W)	MAP, MAP CTR	When the EFIS control panel DATA map switch is selected on, entered or procedural altitude and ETAs for route waypoints are displayed.
	Holding pattern: active route (M), modified route (W), inactive route (B)	MAP, MAP CTR, PLAN	A holding pattern appears when in the flight plan.
	Altitude range arc (G)	MAP, MAP CTR	Based on vertical speed and groundspeed, indicates the approximate map position where the MCP altitude will be reached.
	Altitude profile point and identifier (G)	MAP, MAP CTR	Indicates the approximate map position of the FMC-calculated T/C (top-of-climb), T/D (top-of-descent), S/C (step climb), and E/D (end of descent) points. Predicted altitude/ETA points entered on the FIX page display the altitude / ETA along with the profile point. Deceleration points have no identifier.
	VNAV path pointer (M) and deviation scale (W)	MAP, MAP CTR	Displays vertical deviation from selected VNAV PATH during descent only. Scale indicates ± 400 feet deviation. Digital display is provided when the pointer indicates more than ± 400 feet.

	Procedure turn: active route (M), modified route (W), inactive route (B)	MAP, MAP CTR, PLAN	A procedure turn appears when in the flight plan. It increases in size upon entering the procedure turn.
	Airport and runway (W)	MAP, MAP CTR, PLAN	Displayed when selected as the origin or destination and ND range is 80, 160, 320, or 640 NM.
	Airport (B)	MAP, MAP CTR, PLAN	Displayed if the EFIS control panel ARPT map switch is selected on. Origin and destination airports are always displayed, regardless of map switch selection.
	Airport and runway (W)	MAP, MAP CTR, PLAN	Displayed when selected as the origin or destination and ND range is 10, 20, or 40 NM. Dashed runway centerlines extend 14.2 NM.
	Alternate airports (B)	MAP, MAP CTR, PLAN	PLAN: displays up to four alternate airports at all times. MAP, MAP CTR: displays the FMC or pilot selected primary alternate airport. Displays up to four alternate airports when the EFIS control panel APRT map switch is selected on.
	Energy management circles (B, W)	MAP, MAP CTR	Indicates clean (B) and speedbrake (W) energy management circles as defined on the CDU OFFPATH DES page.
	Selected reference point and bearing distance information (G)	MAP, MAP CTR, PLAN	Displays the reference point selected on the CDU FIX page. Bearing and/or distance from the fix are displayed with dashes (G).

GPS DME-DME VOR-DME LOC INERTIAL	FMC position update status (G)	MAP, MAP CTR	Indicates the system providing FMC position update.
	GPS position (W)	MAP, MAP CTR	When the EFIS POS map switch is selected on, indicates GPS position relative to FMC position.
	ADIRU position (W)	MAP, MAP CTR	When the EFIS control panel POS map switch is selected on, the star indicates ADIRU position relative to FMC position.
	Weather radar returns (R, A, G, M)	MAP, MAP CTR, VOR, APP	The most intense areas are displayed in red, lesser intensity in amber, and lowest intensity green. Turbulence is displayed in magenta.
STA WPT ARPT	Selected map options (B)	MAP, MAP CTR	Displays EFIS control panel selected map options.
CDU L, C, R	Map source annunciation (G)	MAP, MAP CTR	Displays ND source if: <ul style="list-style-type: none"> • CDU is selected on respective navigation source select switch • Both FMCs fail, or • A manually selected FMC fails.
	North up arrow (G)	PLAN	Indicates map background is oriented and referenced to true north.

TCAS


Symbol	Name	ND Mode	Remarks
	TCAS resolution advisory (RA), relative altitude (R)	MAP, MAP CTR, APP, VOR	<p>These symbols are displayed only when the EFIS control panel traffic (TFC) switch is selected on. Refer to Chapter 6.15, Warnings.</p> <p>The arrow indicates traffic climbing or descending at a rate greater than or equal to 500 fpm. At rates less than 500 fpm, the arrow is not displayed.</p> <p>For relative altitude symbols, the number and associated signs indicate altitude of traffic in hundreds of feet relative to the airplane.</p> <p>For absolute altitude symbols, the number indicates altitude of traffic in thousands and hundreds of feet. Relative versus absolute altitude display is selected on the transponder/TCAS control panel.</p> <p>For both relative and absolute altitude, the number is below the traffic symbol when the traffic is below, and above the traffic symbol when the traffic is above the airplane. Absence of the number implies altitude unknown.</p>
	TCAS traffic advisory (TA), relative altitude (A)		
	TCAS proximate traffic, relative altitude (W)		
	TCAS other traffic, relative altitude (W)		

RA 5.3 +09↑ TA 8.9 -12 ↑	TCAS no bearing message (RA-R, TA-A)	MAP, MAP CTR, APP, VOR	Message provides traffic type, range in NM, altitude and vertical direction.
TRAFFIC	TCAS traffic alert message (RA, TA)	All	Displayed whenever a TCAS RA or TA is active. EFIS control panel TFC switch does not have to be selected on.
OFFSCALE	TCAS off scale message (RA, TA)	MAP, MAP CTR, APP, VOR	Displayed whenever RA or TA traffic is outside the traffic area covered by the ND range. Displayed only if the EFIS control panel TFC switch is selected on.
TFC	TCAS mode (B)	MAP, MAP CTR, APP, VOR	Indicates the ND TCAS display is active; the EFIS control panel TFC switch is selected on.
TA ONLY	TCAS mode (B)	All	Indicates TCAS computer is not computing RAs. Displayed whether the EFIS control panel TFC switch is selected on or off.
TCAS TEST	TCAS mode (B)	All	Indicates TCAS is operating in the test mode. Displayed whether EFIS control panel TFC switch is selected on or off.
TCAS OFF	TCAS mode (A)	MAP, MAP CTR, APP, VOR	Displayed when the TCAS/ATC mode switch is not in TA ONLY or TA/RA, if traffic is selected. Not displayed if TCAS is failed.
TCAS FAIL	TCAS mode (A)	MAP, MAP CTR, APP, VOR	Indicates TCAS failure, if traffic is selected.

Radar

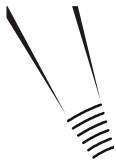
Symbol	Name	ND Mode	Remarks
TEST	Weather radar (WXR) test mode (B) (A)	MAP, MAP CTR, APP, VOR	Weather radar system is selected on the EFIS control panel (refer to Chapter 6.11, Flight Management, Navigation).
WXR	WXR precipitation only mode (B)		
WX+T	WXR and turbulence mode (B)		
VAR	WXR receiver gain (B)		
MAP	Mode used with down-tilt when ground mapping (B)		
+15 to -15	WXR antenna tilt (B)		
WXR FAIL	WXR system failure (A)		
RT	WXR receiver transmitter failure (A)		
ANT	WXR antenna failure (A)		
CONT	WXR control panel failure (A)		
ATT	WXR loss of attitude data (A)		
WEAK	WXR calibration fault (A)		
STAB	Stabilization off (A)		

Look-Ahead Terrain

Symbol	Name	ND Mode	Remarks
	Terrain display (R, A, G, M)	MAP, MAP CTR, APP, VOR	Displays terrain data from the GPWS terrain data base. Terrain 2000 feet below to 500 feet (250 feet with gear down) below the airplane's current altitude (G), terrain 500 feet (250 feet with gear down) below to 2000 feet above the airplane's current altitude (A), terrain more than 2000 feet above airplane's current altitude (R), no terrain data available (M). Color and density vary based on terrain height vs. airplane altitude.
TERR	Terrain mode annunciation (C)	MAP, MAP CTR APP, VOR	Terrain display enabled (manual or automatic display).
TERR TEST	Terrain test mode annunciation (C)	All	GPWS operating in self-test mode.
TERRAIN	Terrain annunciation (R, A)	All	Look-ahead terrain caution alert active (A), look-ahead terrain warning alert active (R).

TERR FAIL	Terrain status annunciations (A)	MAP, MAP CTR, APP, VOR	Look-ahead terrain alerting and display have failed.
TERR POS		MAP, MAP CTR, APP, VOR	Look-ahead terrain alerting and display unavailable due to position uncertainty.
TERR OVRD		MAP, MAP CTR, APP, VOR	GPWS terrain inhibit switch in TERR INHIBIT position.
TERR RANGE DISAGREE	Terrain range status annunciations (A)	MAP, MAP CTR, APP, VOR	Terrain output range disagrees with selected EFIS control panel range.
MAP/TERR RANGE DISAGREE		MAP, MAP CTR	Terrain output range and map display output range disagree with selected EFIS control panel range.

Predictive Windshear

Symbol	Name	ND Mode	Remarks
	Predictive windshear symbol (R, B, A)	MAP, MAP CTR, APP, VOR	Displays windshear location and approximate geometric size (width and depth). Amber radials extend from predictive windshear symbol to help identify location of windshear event.
WINDSHEAR	Windshear annunciation (R, A)	All	Predictive windshear caution active (A). Predictive windshear warning active (R).

ELECTRONIC CHECKLIST (ECL)

Introduction

Normal and non-normal electronic checklists can be displayed on any selected Multifunction Display (MFD). The electronic checklist system is not required for dispatch; a printed checklist must be available on the flight deck.

Electronic checklists can be displayed on any MFD by pushing the checklist display switch on the display select panel. The checklists are controlled using either one of the two cursor control devices. Cursor control devices (CCD) and MFD selection are described in the Display System Controls paragraph of this section.

Electronic Checklist Operation

General

Pushing the checklist display switch on the display select panel displays the proper checklist (refer to the Normal Checklist and Non-Normal Checklist paragraphs in this section for the checklist display priority order). Only one checklist is displayed at a time.

Three types of checklists can be displayed:

- Normal
- Non-normal associated with EICAS messages
- Non-normal not associated with EICAS messages.

As each normal checklist is finished, pushing the checklist display switch displays the next sequential normal checklist.

Some checklist steps must be checked-off by the pilot. Other checklist steps are automatically checked-off from sensed flight deck control positions, aircraft system status, or EICAS messages.

The **CHECKLIST COMPLETE** indicator is displayed at the bottom of all pages of the checklist when all of the line items are either complete, inactive, or overridden, and every page has been displayed. If the flight crew chooses not to perform a particular line item, the line item can be overridden by selecting the **ITEM OVRD** key at the bottom of the page. When a line item is overridden, the text changes color from white to cyan and the current line item box moves down to the next incomplete line item. If the flight crew chooses to not perform an entire checklist, the checklist can be overridden by selecting the **CHKL OVRD** key at the bottom of the page. When a checklist is overridden, the text of the entire checklist changes color from white to cyan, and the **CHECKLIST OVERRIDDEN** indicator is displayed at the bottom of all pages.

Checklist Steps

Each step in a checklist is referred to as a line item. After selecting a checklist, a current line item box automatically encloses the text of the first incomplete line item.

When the cursor is on a line item, a cursor selection box encloses the current line item box and the open loop indicator. When line items are complete, the cursor, cursor selection box, and current line item box move to the next incomplete line item.

Incomplete checklist line items appear as white text. Completed line items appear as green text with a green check mark to the left. Overridden and inactive line items are displayed in cyan.

Checklist Open Loop and Closed Loop Steps

Open loop (not sensed) steps are checklist steps that require crew confirmation.

Open loop steps display a gray box (open loop indicator), in the left margin.

The CCD cursor select switch is used to confirm completed open loop steps.

When the cursor is positioned within the current line item box or open loop indicator, and the CCD cursor select switch is pressed, the checklist line item text color changes from white to green and a green check mark is displayed on the open loop indicator.

Closed loop (sensed) steps are checklist steps that can automatically be completed by system inputs. Closed loop steps display check marks with no gray boxes.

Checklist Pages

The checklist is displayed on one or more pages. Page keys are located on the right side of each checklist containing more than one page. Page keys are not shown on checklists containing only one page.

When a checklist is complete and there are no additional checklists in the non-normal checklist queue, the cursor automatically moves to the NORMAL checklist key in the lower left corner of the display. If a non-normal checklist exists, the cursor automatically moves to the NON-NORMAL checklist key in the lower right corner of the display. Pressing the cursor select switch causes the next appropriate checklist to appear.

When a checklist has more than one page, and the checklist steps on the current page are complete, the cursor automatically moves to the checklist page key corresponding to the next page. CONTINUED is displayed on the bottom of the page. Pressing the cursor select switch advances to the next checklist page.

When the last page is complete, the cursor moves to the NORMAL or NON-NORMAL checklist key as described above.

Checklist Menu Operation

An alternate means of operating the checklist is through the use of menus. The normal, resets, and non-normal menus can be selected by the keys at the top of the checklist page, using the cursor control device.

An EXIT MENU key is located in the lower right corner of all menu displays. This exits the menu page to allow access to the NORMAL and NON-NORMAL checklist keys.

Checklist RESETS Menu

Selecting RESETS displays miscellaneous information (such as checklist database part number and revision information) and the following selectable resets:

- RESET NORMAL
- RESET NON-NORMAL
- RESET ALL – Selecting the resets menu and then the reset key labeled RESET ALL resets all normal and non-normal checklists. The flight crew is prompted to re-accomplish all annunciated non-normal checklists that were previously completed. Use of the RESET ALL function in flight is not recommended.

This provides a way to reset multiple checklists.

Checklist Resets

If a checklist is partially complete or complete and the pilot wishes to begin the checklist again, the checklist must be reset. Selecting the CHKL RESET key at the bottom of the page, while the checklist is displayed, resets the checklist and allows the checklist to be accomplished again.

For certain conditions, resets are required to prepare the checklist for the next phase of flight. There are automatic resets and manual resets.

Checklist Override

Entire checklists can be overridden. By pressing the CHKL OVRD key, the displayed checklist turns to cyan, indicating that it is overridden. The message CHECKLIST OVERRIDDEN is displayed at the bottom of the page. Normal checklist sequence is then resumed. This allows for rapid skipping of checklists. All associated operational notes and deferred line items are removed from their respective target areas, and conditional statements within a checklist are overridden.

Item Override

Item override is used by the flight crew when an item in a checklist will not be accomplished or an item has been accomplished but the closed-loop sensing is not functioning correctly. Overriding an item when required allows the checklist to be completed.

The line item override function is available on all checklists. Selection of the ITEM OVRD key turns the highlighted step to cyan, indicating the step is not applicable and has been overridden. Both closed loop and open loop steps can be overridden.

Conditional statements (both closed and open loop) cannot be overridden. Individual steps within conditional statements can be overridden.

Checklist Access

Air/ground logic, fuel control switch position, and EICAS message level determine the checklist retrieval priority when the checklist display switch is pushed.

Checklist call-up priority order is shown below.

On the ground and both fuel control switches are in the CUTOFF position and both engine start selectors in NORM:

- Checklists associated with any EICAS warning messages
- NORMAL checklists (incomplete or not yet displayed)
- Checklists associated with any EICAS caution messages
- Checklists associated with any EICAS advisory messages
- Unannunciated (no EICAS message) checklists.

On the ground with either fuel control switch in the RUN position, or either engine start selector not in NORM, or in the air:

- Checklists associated with any EICAS warning messages
- Checklists associated with any EICAS caution messages
- Checklists associated with any EICAS advisory messages
- Unannunciated checklists
- NORMAL checklists.

Normal Checklists

Normal electronic checklist use follows the same philosophy as used with paper checklists. The normal procedures are done from memory, then the checklist is read to confirm the actions.

Normal Checklist Menu

Normal checklists are arranged in the menu by phase of flight. If a normal checklist is selected out of sequence, the original normal sequence can be resumed using the NORMAL MENU key or the checklist display switch.

Normal Checklist Automatic Reset Conditions

Automatic checklist resets occur for the following conditions:

- GO-AROUND - If the airplane is in the air, the landing gear is not up, and TO/GA is selected, then all normal checklists beginning with the AFTER TAKEOFF checklist automatically reset.
- TOUCH-AND-GO - If the airplane has transitioned from air to ground, takeoff thrust is reached with groundspeed greater than 80 KIAS, and the thrust reversers not deployed, then all normal checklists beginning with the AFTER TAKEOFF checklist automatically reset.
- NORMAL MENU CHOICE - If a previously completed checklist is selected from the menu, it automatically resets when it is displayed.

Normal Checklist Manual Reset Conditions

Manual checklist resets are required for the following conditions:

- **FULL STOP OR REFUSED TAKEOFF (RTO) WITH SUBSEQUENT TAKEOFF** - The flight crew selects the **NORMAL MENU** key to return to the **BEFORE TAKEOFF** checklist
- **RESETS FUNCTION** - The flight crew activates the **RESETS** menu key and selects the key labeled **RESET NORMAL**
- **INDIVIDUAL CHECKLIST RESET** - Selection of the **CHKL RESET** key resets any displayed checklist.

Normal Checklist Access

Normal checklist selection sequence follows progressive phases of flight. Phases of flight are distinguished by completion of the previous phase checklist and not by air/ground logic. The checklist is automatically reset after completing the last checklist, at power down, or following a manual reset of all normal checklists.

The checklist order is:

- **RECEIVING AIRCRAFT**
- **BEFORE START**
- **AFTER START**
- **BEFORE TAKEOFF**
- **AFTER TAKEOFF**
- **IN RANGE**
- **APPROACH**
- **LANDING**
- **AFTER LANDING**
- **PARKING**
- **TERMINATION**

As each normal checklist is completed, the next unfinished normal checklist is displayed.

Any normal checklist can be accessed using the **NORMAL MENU**.

Normal Checklist, Completing or Leaving

At the completion of each checklist (all steps are complete or overridden), the appropriate message appears at the bottom of the page:

- **CHECKLIST COMPLETE** (white text on green background)
- **CHECKLIST OVERRIDDEN** (white text on cyan background).

After the checklist is complete, but still displayed, a change to the position of a closed loop sensed switch results in the checklist no longer showing **CHECKLIST COMPLETE**.

If a pilot attempts to leave an incomplete checklist, the text in the **NORMAL** checklist key changes color to amber to indicate that one or more unfinished normal checklists items exist. Activating the amber **NORMAL** checklist key returns the display to the first unfinished step in the first unfinished normal checklist.

Non-Normal Checklists

Non-normal electronic checklist use is designed to follow the same philosophy as used with printed checklists. Non-normal checklists are done by read-and-do. If a checklist has memory steps, those steps are accomplished before accessing the checklist.

Non-Normal Checklist Menu

NON-NORMAL MENU selections are arranged by aircraft system. Sub-menus are used to group the appropriate checklists.

Non-Normal Checklist Automatic Reset Conditions

Automatic checklist resets occur if the non-normal condition no longer exists.

Non-Normal Checklist Manual Reset Conditions

Manual checklist resets are required for the following conditions:

- **RESET NON-NORMAL** – selecting the resets menu and then the reset key labeled **RESET NON-NORMAL** resets all non-normal checklists. The flight crew is prompted to reaccomplish all annunciated non-normal checklists that were previously completed. Use of the **RESET NON-NORMAL** function in flight is not recommended.
- **INDIVIDUAL CHECKLIST RESET** – selection of the **CHKL RESET** key resets any displayed checklist. The checklist is then ready to accomplish again.

Non-Normal Checklist Access And Checklist Icon

Annunciated non-normal checklists are accessed by pushing the checklist display switch. Any non-normal checklist can be accessed using the NON-NORMAL MENU.

EICAS messages determine which non-normal checklist is automatically displayed. EICAS alert messages with associated incomplete or unaccessed checklist procedures are displayed with an icon (a white, empty box) to the left of the message. The icon indicates checklist status. The presence or absence of the icon indicates:

- Icon displayed – the checklist for the displayed message has not been accessed, or the checklist has incomplete steps.
- Icon not displayed – all checklist steps are complete, there is no checklist procedure for the displayed message, or another message is displayed whose corresponding checklist inhibits display of the icon.

When pushing the checklist display switch and a single EICAS message exists, the non-normal checklist for that condition is displayed. If multiple active EICAS messages exist, pushing the checklist display switch displays a list showing the non-normal checklists ready for display. This list represents the non-normal checklist queue. If the number of checklists in the queue exceeds 10, a page indicator appears adjacent to the list.

The checklist queue order is similar to EICAS message priority:

- EICAS WARNING
- EICAS CAUTION
- EICAS ADVISORY
- UNANNUNCIATED.

When a message becomes active, the corresponding checklist is automatically placed in the queue. After checklist completion, a message may still exist, but the checklist is removed from the queue. A checklist is also removed from the queue when another message is displayed whose corresponding checklist inhibits placement of the checklist in the queue.

Selection of the desired checklist in the queue is accomplished using the cursor, which is initially placed on the first checklist. Once a checklist is selected and completed, pressing the NON-NORMAL key returns the display to the queue, if additional non-normal conditions exist.

Non-Normal Checklist Conditional Statements

There are two types of conditional statements within checklists:

- Closed loop (aircraft system status sensed)
- Open loop (aircraft system status not sensed).

Open loop conditional statements are followed by selections labeled YES and NO. The cursor is placed adjacent to the YES - NO line, requiring the pilot to use the cursor to select the appropriate answer.

If the answer to conditional statement is YES, the steps immediately following the conditional statement become active. If the answer to the conditional statement is NO, the steps immediately following the conditional statement become inactive and turn a cyan color to indicate the steps are not applicable.

The current line item box skips past the cyan items. Cyan steps are not selectable. Any associated operational notes are removed from the notes page and deferred line items are removed from the target normal checklist when they are displayed in cyan. YES-NO selections remain active even after a selection is made. The pilot can change selections at any time.

Sometimes a group of two or more open-loop conditional line items are designated as a mutually exclusive set. When the pilot answers YES to any one of the items in the exclusive set, all other items are automatically answered NO. However, the opposite is not true. If all of the items but one are answered NO, the last item is not automatically answered YES. The pilot must manually select YES to one of the conditional line items in the exclusive set.

The closed loop conditional statement function is identical to open loop except the decision is made automatically by using airplane system status sensing.

When the conditional statement is satisfied, the prompt moves to the next unfinished conditional statement step. If the condition is not true, the steps immediately following the conditional statement are no longer applicable and change color to cyan. The current line item box skips past the cyan items.

Non-Normal Checklist, Completing or Leaving

At the completion of each checklist (all steps are either complete, inactive, or overridden), the appropriate message appears at the bottom of the page:

- CHECKLIST COMPLETE (white text on green background)
- CHECKLIST OVERRIDDEN (white text on cyan background)
- CHECKLIST COMPLETE EXCEPT DEFERRED ITEMS (white text on green background).

If the checklist was left unfinished, the text in the NON-NORMAL checklist key in the lower right corner of the display turns amber to indicate that at least one non-normal checklist was left unfinished.

Non-Normal Unannunciated Checklists

Non-normal checklists not associated with specific EICAS messages are unannunciated checklists. Unannunciated checklists are accessed only through menu selection. Unannunciated checklists are the first sub-menu item when the NON-NORMAL MENU is accessed. This menu selection provides quick menu access to all unannunciated checklists.

Non-Normal Checklist Operational Notes

Checklist operational notes are used for ongoing consequences of the non-normal condition, such as:

- Inoperative equipment lists
- Operational limitations.

Operational notes are selectable through the operational NOTES key at the bottom of the page. After completion of a non-normal checklist that includes operational notes, the notes are accessible during all subsequent phases of flight. Each operational note includes a reference title for the EICAS message that generated the note.

If there are multiple pages of operational notes, page keys are displayed. If there is only one notes page, or all pages have been accessed, the cursor is placed on the NON-NORMAL checklist key, if it is displayed, or moves to the NORMAL checklist key.

Operational notes are dependent upon the status of the non-normal condition causing the note. If the condition goes away, the EICAS message and associated notes are removed from the operational notes display.

Non-Normal Checklist Deferred Items

Deferred line items are items that are part of a non-normal checklist, but must be accomplished later in the flight, usually during approach.

If a non-normal checklist containing deferred items is displayed, the items are automatically attached to the appropriate normal checklist. Each set of deferred items is referenced to the EICAS message that generated the original non-normal checklist.

A non-normal checklist containing deferred items is considered complete when all applicable steps prior to the deferred items have been accomplished. The message CHECKLIST COMPLETE EXCEPT DEFERRED ITEMS is displayed at the bottom of the page.

If a non-normal condition occurs after completion of the approach or landing checklist, the originating non-normal checklist is considered incomplete until all steps including the deferred items are accomplished.

Non-Normal Checklist Timers

Where required, an automatic timer appears in the upper right hand corner of the checklist page to help in the completion of steps requiring time delays. All timers are countdown timers. Timers can be associated with conditional statements. In these cases, the timers are activated by the completion of a step just prior to the conditional statement.

Timers are activated by completing the step just prior to the line item associated with the timer. Timers run in the background. This allows the flight crew to leave the checklist to accomplish other tasks and then return to the checklist, where an accurate countdown time is displayed. Timers initially appear in white. When the time elapses, the timer displays 00:00 and the color changes to amber. When the current line item box moves to the next incomplete item, the expired timer is removed from the display.

Inhibited Checklist Line Items

When a single aircraft system failure results in the display of multiple EICAS alert messages (a primary message and one or more consequential messages), inhibited checklist line items allow unnecessary non-normal checklists (consequential checklists) to be inhibited from display in the checklist queue.

Consequential EICAS alert messages may be displayed as a result of a primary failure condition. For example, an **AUTO SPEEDBRAKE** message is displayed as a result of a **HYD PRESS SYS C** condition. Consequential EICAS alert messages also may result from a non-normal checklist crew action. For example, a **PACK L** message is displayed when the crew selects the pack off during accomplishment of the **SMOKE AIR CONDITIONING** checklist. Corresponding consequential checklists are inhibited by the inhibited checklist line items in the primary checklist. The inhibited checklist line item lists the consequential checklists which are inhibited. The inhibit has the following effects on a consequential checklist:

- Checklist icon is removed from corresponding EICAS message
- Checklist is removed from checklist queue
- Notes are not collected on operational notes page
- Deferred items are not collected in normal checklists.

If consequential checklist steps, notes, and information are applicable to the primary failure condition, then these are included in the primary checklist.

Electronic Checklist System Inoperative

If the checklist display switch is pushed and the electronic checklist system is inoperative, the message **CHECKLIST NOT AVAILABLE** is displayed on the MFD. If the electronic checklist system has been disabled by maintenance, the message **CHECKLIST DISABLED** is displayed on the MFD.

When the electronic checklist system is inoperative or disabled, checklist icons are not displayed on the EICAS display for any messages.

STANDBY FLIGHT INSTRUMENTS / CLOCK

Standby Flight Instruments

The standby flight instruments include:

- Standby attitude indicator
- Standby altimeter
- Standby airspeed indicator
- Standby magnetic compass.

Standby Attitude Indicator

The standby attitude indicator displays SAARU attitude. A bank indicator and pitch scale is provided.

Standby Airspeed Indicator

The standby airspeed indicator displays airspeed calculated from two standby air data modules (one pitot and one static). It provides current airspeed in knots as a digital readout box and with an airspeed pointer.

Standby Altimeter

The standby altimeter displays altitude from the standby (static) air data module. Current altitude is displayed digitally. A pointer indicates altitude in hundreds of feet. The pointer makes one complete revolution every 1,000 feet.

Standby Magnetic Compass

A standard liquid-damped magnetic standby compass is provided. A card located near the compass provides heading correction factors.

Clock

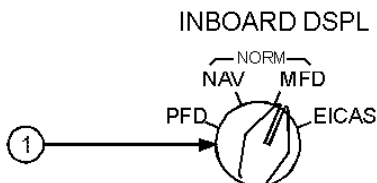
A clock is located on each forward panel. Each clock displays airplane information management system (AIMS) generated UTC time and date, or manually set time and date. The AIMS UTC time comes from the Global Positioning System (GPS). In addition to time, the clocks also provide alternating day and month-year, elapsed time and chronograph functions.

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CONTROLS AND INDICATORS

INBOARD DISPLAYS AND HEADING REFERENCE

Inboard Display Controls



FORWARD PANELS

7771528

① INBOARD Display (DSPL) Selector

Selects what is displayed on each inboard display unit.

PFD - Displays the PFD, blanks the PFD on the outboard display unit, and inhibits selections made from the display select panel.

NAV - Displays the ND and inhibits selections made from the display select panel.

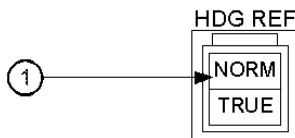
MFD - displays the selection made on the display select panel.

EICAS -

- Displays EICAS
- Inhibits most selections made from the display select panel (limited ENG, FUEL, and AIR displays can be selected)
- Blanks the upper center display unit.

Note: The PFD automatically appears on an inboard display unit if the adjacent outboard display unit fails, regardless of switch position.

Heading Reference Controls



LEFT FORWARD PANEL

7771529

① Heading Reference (HDG REF) Switch

Pushing alternately selects the heading reference for the PFDs, NDs, AFDS, and FMCs.

NORM -

- Normally references magnetic north
- Automatically references true north when north of 82°N or south of 82°S latitude or within the vicinity of the magnetic poles (PFDs, NDs, and FMCs)
- Provides no reference for AFDS roll modes other than LNAV when north of 82°N or south of 82°S latitude or in the vicinity of the magnetic poles.

TRUE - References true north regardless of latitude.

When the AFDS roll mode is HDG SEL, switching the heading reference switch from NORM to TRUE or TRUE to NORM engages the HDG HOLD mode.

When the AFDS roll mode is TRK SEL, switching the heading reference switch from NORM to TRUE or TRUE to NORM engages the TRK HOLD mode.

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Flight Manual

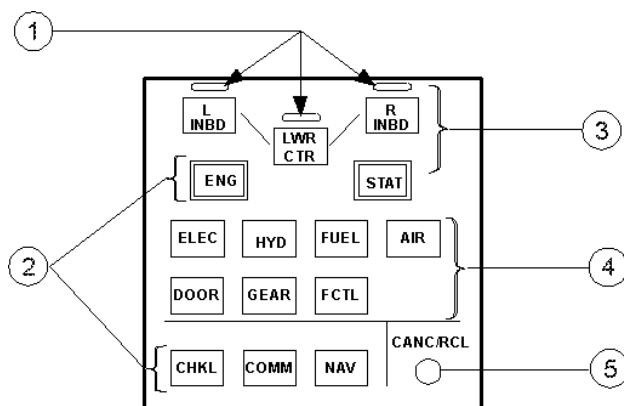
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DISPLAY SELECT PANEL**GLARESHIELD PANEL**

7771530

① Display Lights

Illuminates to show the display unit the display select panel controls.

② Display Switches

Pushing the switch displays the associated display. Pushing the same switch a second time blanks the display or (left and right inboard display units) redisplay the ND if there is only one page of messages. If there are more than one page of messages, pushing STAT pages through the messages.

ENG - Secondary engine EICAS.

STAT - Status page:

- Hydraulic system indications
- APU indications
- Oxygen system indications
- Status messages for dispatch determination

CHKL - Checklist (this section).

COMM - Communications.

NAV - Navigation display (this section).

③ Multifunction Display (MFD) Switches

Selects the active MFD (left inboard, lower center, or right inboard display unit) for display selection.

The appropriate left or right INBOARD DISPLAY selector must be in the MFD or EICAS position. The other display select panel switches determine what is displayed on the selected MFD.

④ Synoptic Switches

Pushing the switch displays the associated synoptic. Synoptics present a simplified view of system status as an aid for crew situational awareness. Pushing the same switch a second time blanks the display or (left and right inboard display units) redisplay the ND.

ELEC - Electrical System (Section 6.6).

HYD - Hydraulic System (Section 6.13).

FUEL - Fuel System (Section 6.12).

AIR - Air Systems (Section 6.2).

DOOR - Doors (Section 6.1).

GEAR - Landing Gear and Brake Systems (Section 6.14).

FCTL - Flight Control System (Section 6.9).

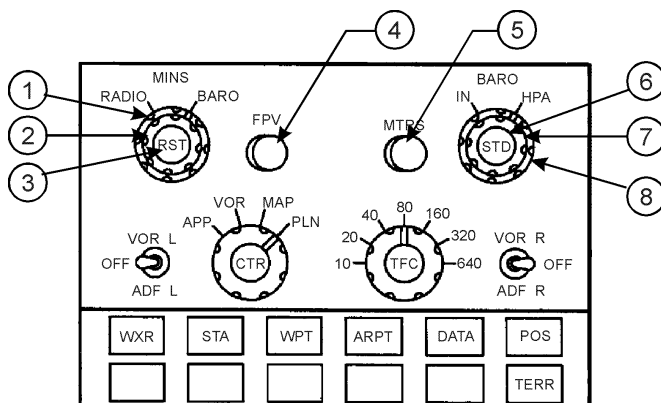
⑤ Cancel/Recall (CANC/RCL) Switch

Refer to Warnings, Section 6.15.

EFIS CONTROL PANELS

The left EFIS control panel controls the left PFD and ND. The right EFIS control panel controls the right PFD and ND.

EFIS Control Panel PFD Controls



GLARESHIELD PANEL

7771525

- ① Minimums (MINS) Reference Selector (outer)
 - RADIO - Selects radio altitude as the PFD minimums reference.
 - BARO - Selects barometric altitude as the PFD minimums reference.
- ② Minimums (MINS) Selector (middle)
 - Rotate (slew)- Adjusts the PFD radio or baro minimums altitude.
- ③ Minimums Reset (MINS RST) Switch (inner)
 - Push -
 - Resets the PFD minimums alert display
 - Blanks the minimums display when green.
- ④ Flight Path Vector (FPV) Switch
 - Push - Displays the PFD flight path vector.
- ⑤ Meters (MTRS) Switch
 - Push - Displays PFD altitude meters indications.

⑥ Barometric Standard (BARO STD) Switch (inner)

Push -

- Selects the standard barometric setting (29.92 inches Hg/1013 HPA) for the PFD barometric reference
- If STD is displayed, selects the preselected barometric setting
- If no preselected barometric setting is displayed, displays the last value before STD was selected.

⑦ Barometric (BARO) Selector (middle)

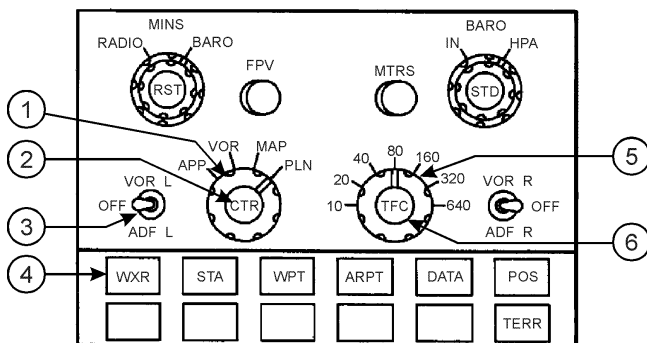
Rotate (slew) - Adjusts the PFD barometric reference.

⑧ Barometric (BARO) Reference Selector (outer)

IN - selects inches of mercury as the PFD barometric reference.

HPA - selects Hectopascals as the PFD barometric reference.

EFIS Control Panel ND Controls



GLARESHIELD PANEL

7771526

① ND Mode Selector (outer)

Selects the desired ND map display.

APP -

- Displays localizer and glideslope information in heading-up format
- Displays reference ILS receiver, ILS frequency or identification, course, and DME
- Weather radar and TCAS are not displayed in CTR APP mode.

VOR -

- Displays VOR navigation information in heading-up format
- Displays reference VOR receiver, VOR frequency or identification, course, DME, and TO/FROM indication
- Weather radar and TCAS are not displayed in CTR VOR mode.

MAP -

- Displays FMC-generated route and map information, airplane position, heading, and track
- Displays waypoints, including the active waypoint, within the selected range
- Displays VNAV path deviation.

PLN -

- Displays a nonmoving, true north-up, route depiction
- The airplane symbol represents actual airplane position
- Allows route step-through using the CDU legs page
- Weather radar and TCAS are not displayed in PLN mode.

② ND Center (CTR) Switch (inner)

Push -

- Displays the full compass rose (centered) for APP, VOR, and MAP modes
- Subsequent pushes alternate between expanded and centered displays.

③ VOR/ADF Switches

Displays VOR or ADF information on the respective ND.

VOR - Displays the VOR pointer, VOR frequency or identification and associated DME information in all modes except PLAN.

OFF - Removes VOR and ADF displays.

ADF - Displays the ADF pointer and ADF frequency or identification in all modes except PLAN.

④ Map Switches

The map switches:

- Select detailed ND information displays
- Displays can be selected simultaneously
- Second push removes the information.

WXR (weather radar) - displays weather radar information (refer to Section 6.15, Warning Systems).

STA (station) -

- Displays high and low altitude navigation aids, if the ND range selector is in the 10, 20 or 40 NM range
- Displays high altitude navigation aids, if the ND range selector is in the 80, 160, 320, or 640 NM range.

WPT (waypoint) - Displays waypoints, if the ND range selector is in the 10, 20 or 40 NM range.

APRT (airport) - Displays airports on all ranges.

DATA - Displays the FMC estimated time of arrival, altitude at each waypoint, and altitude constraints at each waypoint.

POS (Position) -

- Displays ADIRU and GPS positions
- Displays VOR raw data radials extended from the nose of the airplane to the stations.

TERR (Terrain) – Displays terrain data. (Refer to Section 6.15, Warning Systems.)

⑤ ND Range Selector (outer)

Selects the desired ND nautical mile range scale.

⑥ ND Traffic (TFC) Switch (inner)

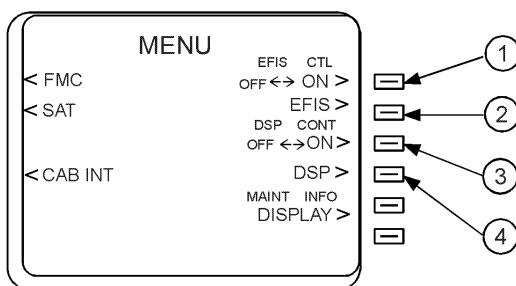
Push - displays TCAS ND information. (Refer to Section 6.15, Warning Systems.)

EFIS CONTROL PANELS AND DISPLAY SELECT PANEL (DSP) - CDU ALTERNATE CONTROL

The CDU provides an alternate way to control the functions of the EFIS control panel and/or the display select panel.

Note: The control callouts on the following pages correspond to the control names on the EFIS control panels and the display select panel. Explanations of the CDU functions are the same as on the related control panels.

CDU EFIS/DSP Control Selection

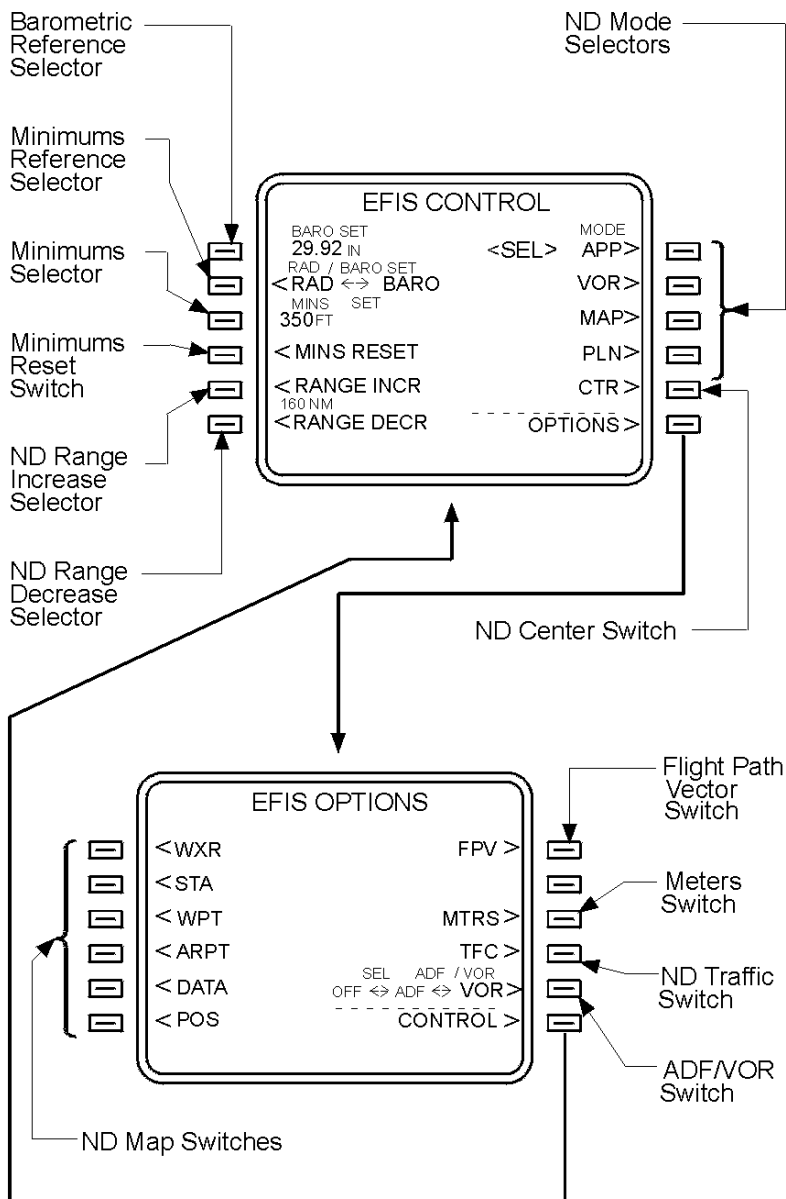


CDU

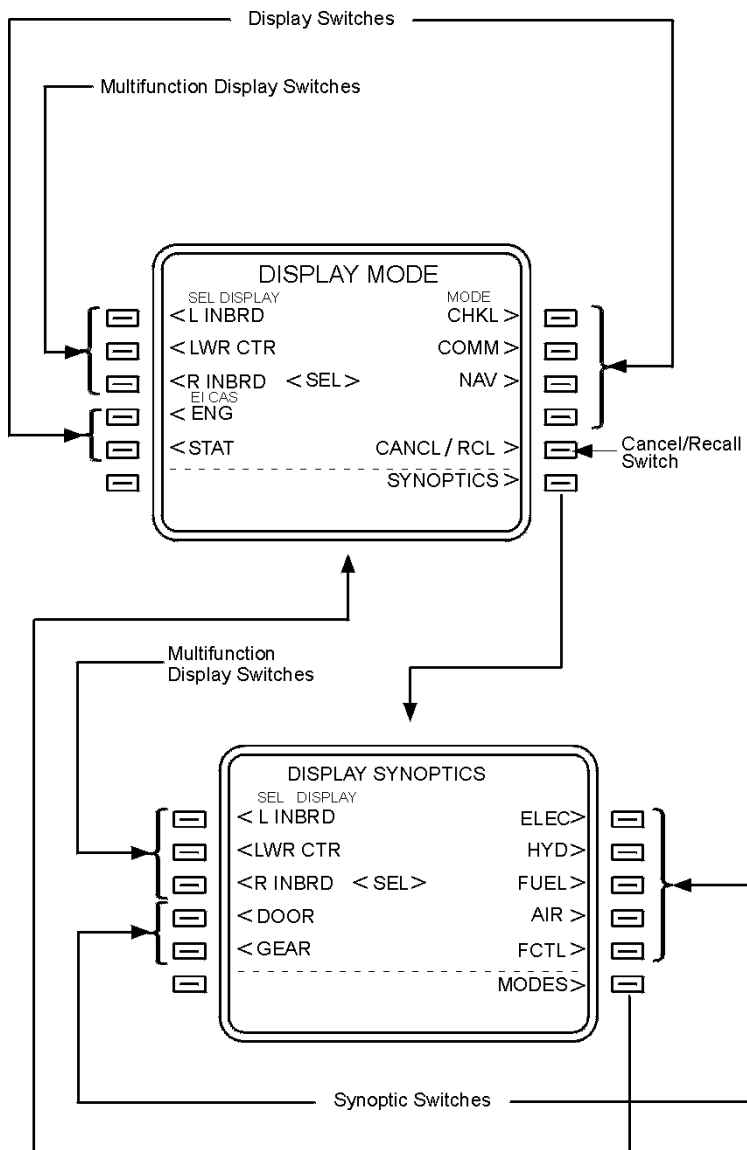
7771539

- ① **EFIS Control (CTL) Select Key**
Transfers control of the EFIS from the EFIS control panel to the CDU (left EFIS control panel transfers to the left CDU, right EFIS control panel transfers to the right CDU).
- ② **EFIS Page Select Key**
Selects the EFIS CONTROL page when EFIS control is on.
- ③ **Display Select Panel Control (DSP CTL) Select Key**
Transfers control of the display select panel control from the display select panel to the CDU.
- ④ **Display Select Panel (DSP) Page Select Key**
Selects the DISPLAY SELECT PANEL CONTROL page when the DSP control is on.

EFIS Control CDU Pages

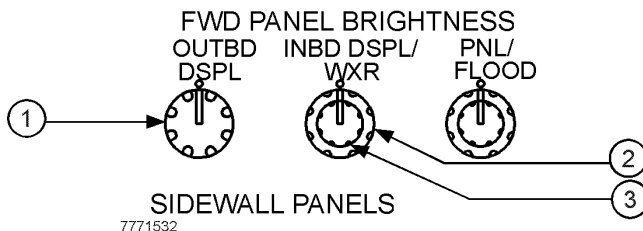


Display Select CDU Pages



DISPLAY BRIGHTNESS CONTROLS

Forward Panel Brightness Controls



The left panel is shown.

- ① Outboard Display (OUTBD DSPL) Brightness Control
Rotate - Adjusts the brightness of the outboard display unit.
- ② Inboard Display (INBD DSPL) Brightness Control (outer)
Rotate - Adjusts the brightness of the inboard display unit.
- ③ Inboard Display Weather Radar (INBD DSPL WXR) Brightness Control (inner)
Rotate - Adjusts weather radar display brightness on the inboard display unit.

Center Panel Brightness Controls



FORWARD AISLE STAND PANEL

7771533

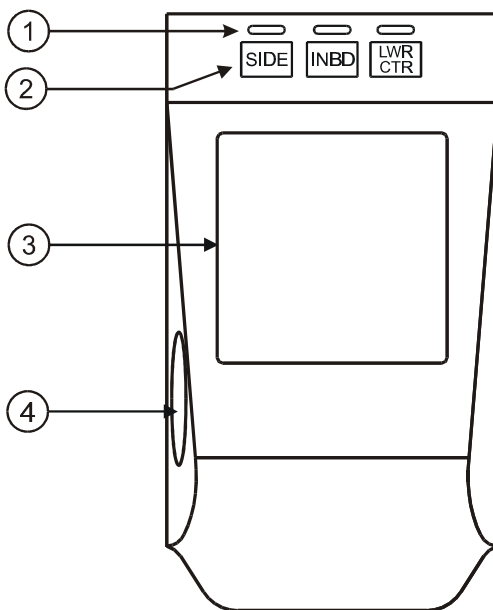
- ① Upper Display (UPR DSPL) Brightness Control
Rotate - Adjusts the brightness of the upper center display unit.
- ② Lower Display (LWR DSPL) Brightness Control (outer)
Rotate - Adjusts the brightness of the lower center display unit.
- ③ Lower Display Weather Radar (LWR DSPL WXR) Brightness Control (inner)
Rotate - Adjusts weather radar brightness on the lower center display unit.

CURSOR CONTROL DEVICE (CCD)

The left CCD controls the left inboard and lower center display unit cursor position and operation.

The right CCD controls the right inboard and lower center display unit cursor position and operation.

The left CCD is shown; the right CCD is similar, except the cursor select switch and the LWR CTR switches are located on the opposite side of the CCD.



CONTROL STAND

① Cursor Location Lights

The associated annunciator light illuminates to indicate which display unit is selected.

② Cursor Location Switches

Selects the display unit where the cursor appears (inboard, or lower center display) and automatically deselects the previous display unit.

③ Touch Pad

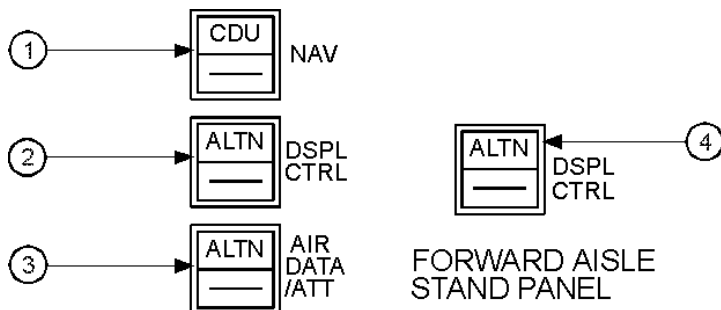
Finger movement on the touch pad moves the cursor on the selected display. Lifting the finger off the pad and putting it back down in a different location (except the corner areas) does not move the cursor. The cursor only moves when the finger is moved on the touch pad surface.

Corner areas - Placing a finger in one of the four corners puts the cursor in that respective corner of the screen. Moving the cursor into a corner region without lifting the finger from the pad does not have this effect.

④ Cursor Select Switch

Push - Activates the area of the screen that the cursor is currently in, such as a menu item or command button. The area is highlighted by a white border to indicate it can be selected.

The switch is used to select menus, checklists, checklist steps, and other functions.

INSTRUMENT SOURCE SELECT PANELS**FORWARD PANELS**

7771527

The instrument source switches are provided for use if a display-related failure is not detected by automatic system monitors. Normally, the display system automatically reconfigures for failures without the pilot having to use these switches.

① Navigation (NAV) Source Switch

Off - Normal position (CDU not visible, switch out):

- With the FMC selector in AUTO, the active FMC provides the information to generate the ND map
- If both FMCs fail, the CDU provides navigation data.

CDU - Non-normal position (CDU visible, switch in). The selected CDU generates the ND map. Normally, the sources are:

- Left ND map - Left CDU
- Right ND map - Right CDU.

② Display Control (DSPL CTRL) Source Switch

Off - Normal position (ALTN not visible, switch out):

- Automatically selects display processing channels for the left outboard and inboard, or right outboard and inboard display pairs
- Reconfigures display processing channels as required for display unit or processing channel failures.

ALTN - Non-normal position (ALTN visible, switch in). An alternate display processing channel is selected to replace the current display processing channel.

③ Air Data / Attitude (AIR DATA/ATT) Source Switch

Off - Normal position (ALTN not visible, switch out):

- The ADIRU provides air data and attitude information to the PFD and ND
- Alternate sources or the SAARU are automatically selected to replace ADIRU air data or attitude, as required.

ALTN - Non-normal position (ALTN visible, switch in). The PFD and ND alternate air data/attitude source is selected as follows:

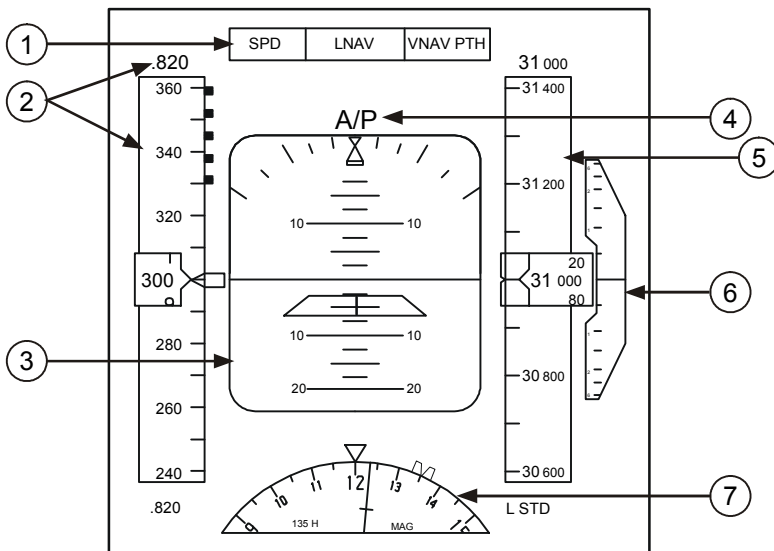
- Air data (Captain): SAARU single channel
- Air data (First Officer): ADIRU single channel
- Attitude (Captain and First Officer): SAARU.

④ Center Display Control (DSPL CTRL) Source Switch

Same as the display control source switches for the left and right inboard and outboard display units, except this switch controls the upper center and lower center display units.

PRIMARY FLIGHT DISPLAY (PFD)

PFD Indications



7771566

Flight Mode Annunciations

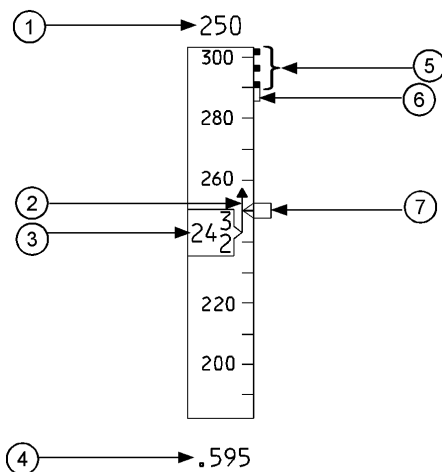
- ① Flight Mode Annunciations
- ② Airspeed/Mach Indications
Displays Air Data Inertial Reference System (ADIRS) airspeed information and other airspeed related information.
- ③ Attitude, Steering, and Miscellaneous Indications
Displays ADIRS attitude information.
- ④ Autopilot, Flight Director System Status
Refer to Section 6.4, Automatic Flight.
- ⑤ Altitude Indications
Displays ADIRS altitude and other altitude-related information.

⑥ Vertical Speed Indication

Displays ADIRS vertical speed and other vertical speed information.

⑦ Heading and Track Indications

Displays current ADIRS heading, track and other heading information.

PFD Airspeed Indications

7771502

① Selected Speed

Displays the airspeed/Mach selected in the mode control panel MCP IAS/MACH window (refer to Section 6.4, Automatic Flight).

Displays the FMC-computed airspeed/Mach when the MCP IAS/MACH window is blank.

② Speed Trend Vector

Indicates predicted airspeed in ten seconds based on current acceleration or deceleration.

③ Current Airspeed

Indicates current ADIRS airspeed.

The box around the current airspeed indication turns amber when airspeed is below minimum maneuvering speed.

④ Current Mach

Displays current ADIRS Mach.

⑤ Maximum Speed

Indicates maximum permissible airspeed as limited by the lowest of the following:

- V_{mo}/M_{mo}
- Landing gear placard speed, or
- Flap placard speed.

⑥ Maximum Maneuvering Speed

When displayed, indicates maneuver margin to buffet. May be displayed when operating at high altitude at relatively high gross weights.

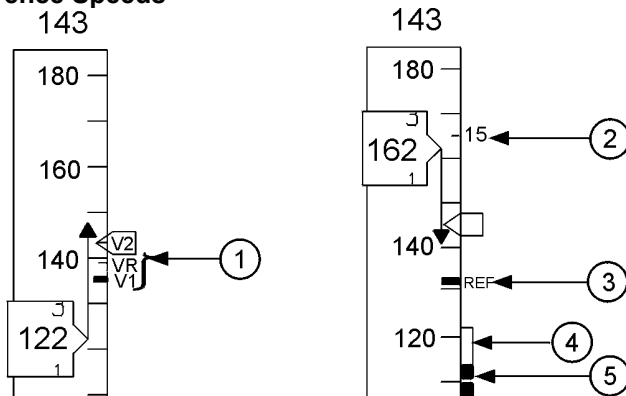
⑦ Speed Bug

Points to the airspeed/Mach selected in the MCP IAS/MACH window.

Indicates FMC-computed airspeed when the MCP IAS/MACH window is blank.

The bug is five knots in height.

When the selected speed is off scale, the bug is parked at the top or bottom of the tape, with only one half the bug visible.

PFD Reference Speeds

7771503

① Takeoff Reference Speeds

Displays the takeoff reference speeds V_1 , V_R (displays R if V_R is within 4 knots of V_1 or V_2), and V_2 , selected on the CDU (refer to Section 6.11, Flight Management, Navigation):

- Displayed for takeoff
- NO V SPD is displayed if V speeds are not selected on the CDU
- V_1 is displayed at the top of the airspeed indication when selected and if the value is off the scale
- V_1 and V_R are removed at lift-off
- V_2 is removed on climb-out:
 - When flap retraction begins, or
 - After 10 minutes have passed without flap lever movement, or
 - After V_{REF} has been selected (for a turn-back).

② Flap Maneuvering Speeds

Indicates flap maneuvering speed for flap retraction or extension.

Not displayed above approximately 20,000 feet altitude.

③ Landing Reference Speed

Displays the V_{REF} speed as selected on the CDU (refer to Section 6.11, Flight Management, Navigation).

V_{REF} speed is displayed at the bottom of the airspeed indication when the value is off the scale.

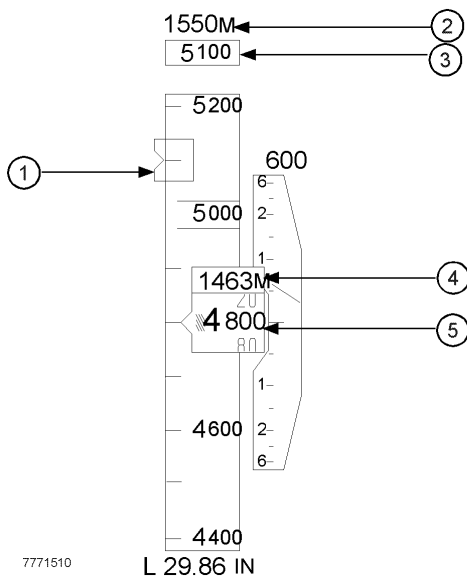
④ Minimum Maneuvering Speed

Indicates maneuver speed margin to stick shaker or low speed buffet.

⑤ Minimum Speed

Indicates the airspeed where stick shaker activates.

PFD Altitude Indications



① Selected Altitude Bug

Indicates the altitude set in the MCP altitude window.

When the selected altitude is off scale, the bug is parked at the top or bottom of the tape, with only one half the bug visible.

② Selected Altitude - Meters

Displayed when MTRS is selected on the EFIS control panel MTRS switch.

Indicates selected altitude in meters (selected in feet in the MCP altitude window).

Displays in 10 meter increments.

③ Selected Altitude

Displays the altitude set in the MCP altitude window.

The selected altitude box is highlighted in white between 900 feet and 200 feet prior to reaching the selected altitude.

④ Current Altitude - Meters

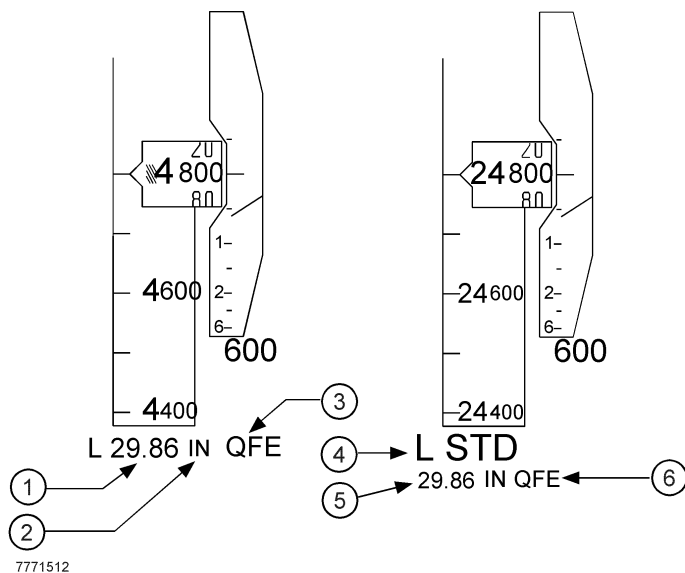
Displayed when MTRS is selected on the EFIS control panel MTRS switch.

Displays altitude in meters.

⑤ Current Altitude

Indicates current ADIRS altitude.

PFD Barometric Indications



① Barometric Setting

Indicates the barometric setting selected on the EFIS control panel barometric selector.

STD is displayed when STD is selected on the EFIS control panel barometric STD switch.

The display is boxed and changes to amber if a barometric setting is set and altitude climbs above the transition altitude, or if STD is set and altitude descends below the transition flight level.

② Barometric Reference

Indicates the barometric setting units selected on the EFIS control panel barometric reference selector:

- IN is inches of mercury
- HPA is Hectopascals.

③ QFE Altitude Reference

Indicates QFE altitude reference selected on the CDU APPROACH REF page.

When selected, QFE is boxed for 10 seconds.

The altitude tape is shaded green during QFE operation.

When QNH is selected, the green shading is removed; QNH is displayed for 10 seconds, then blanks.

④ Autopilot/Flight Director Barometric Source

L or **R** indicates that the left or right EFIS control panel is the barometric setting reference for the autopilot or flight director (the same indication is displayed on both PFDs).

Displayed when a flight director switch is **ON** or the autopilot is engaged.

- F/D - One turned on and one not on determines **L** or **R**
- F/D - Both on - **L** is displayed
- A/P - First one pushed on determines **L** or **R**.

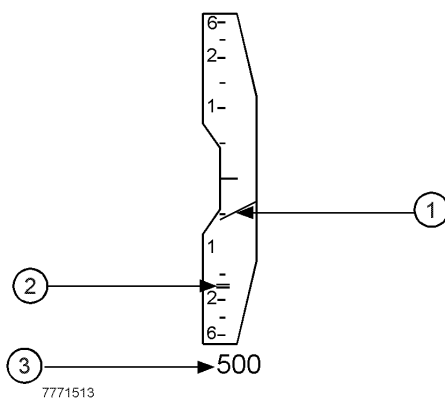
⑤ Preselected Barometric Setting

A barometric setting can be preselected when **STD** is displayed.

The preset barometric setting is selected on the EFIS control panel barometric selector and is displayed below **STD**.

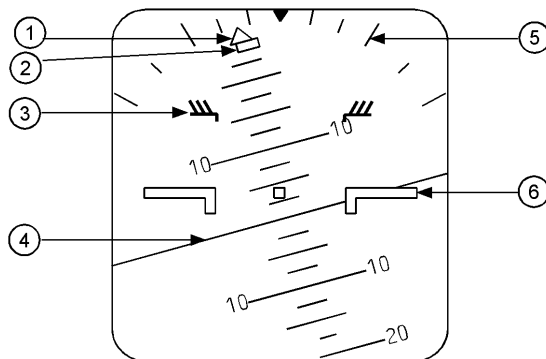
⑥ QFE

When **STD** is selected, a small QFE appears when QFE is selected.

PFD Vertical Speed Indications

- ① Vertical Speed Pointer
Indicates current vertical speed.
- ② Selected Vertical Speed Bug
Indicates the speed selected in the MCP vertical speed window with the v/s pitch mode engaged.
- ③ Vertical Speed
Displays vertical speed when greater than 400 feet per minute.
The display is located above the vertical speed indication when climbing and below when descending.

PFD Attitude Indications

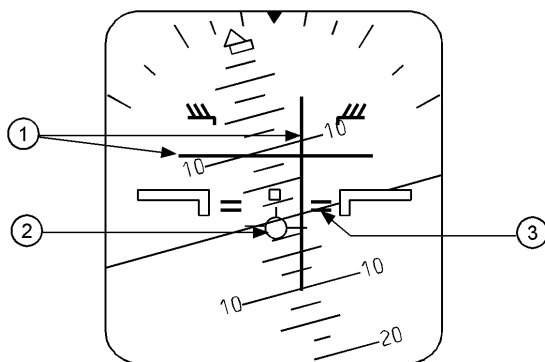


7771504

- ① **Bank Pointer**
Indicates ADIRS bank in reference to the bank scale.
Fills and turns amber if bank angle is 35 degrees or more.
- ② **Slip/Skid Indication**
Displaces beneath the bank pointer to indicate slip or skid.
Fills white at full scale deflection.
Turns amber if bank angle is 35 degrees or more; fills amber if the slip/skid indication is also at full deflection.
- ③ **Pitch Limit Indication**
Indicates pitch limit (stick shaker activation point for the existing flight conditions).
Displayed when the flaps are not up, or at slow speeds with the flaps up.
- ④ **Horizon Line and Pitch Scale**
Indicates the ADIRS horizon relative to the airplane symbol.
Pitch scale is in 2.5 degree increments.
- ⑤ **Bank Scale**
Fixed reference for the bank pointer.
Scale marks are at 0, 10, 20, 30, 45, and 60 degrees.
- ⑥ **Airplane Symbol**
Indicates airplane attitude with reference to the ADIRS horizon.

PFD Steering Indications

Note: Refer to Section 6.15, Warnings, for TCAS Steering Indications and Time Critical Warnings.



7771505

① Flight Director Pitch and Roll Bars

Indicates flight director pitch and roll steering commands.

Refer to Section 6.4, Automatic Flight.

② Flight Path Vector (FPV)

Displays flight path angle and drift angle if:

- FPV is selected on the EFIS control panel, or
- FPA (flight path angle) is selected on the MCP.

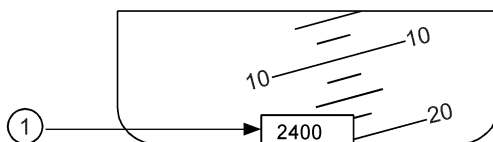
Flight path angle is displayed relative to the horizon line.

Drift angle is represented by the perpendicular distance from the centerline of the pitch scale to the FPV symbol.

③ Selected Flight Path Angle (FPA)

Indicates the selected flight path angle when FPA is selected on the MCP.

PFD Radio Altitude Indications



7771506

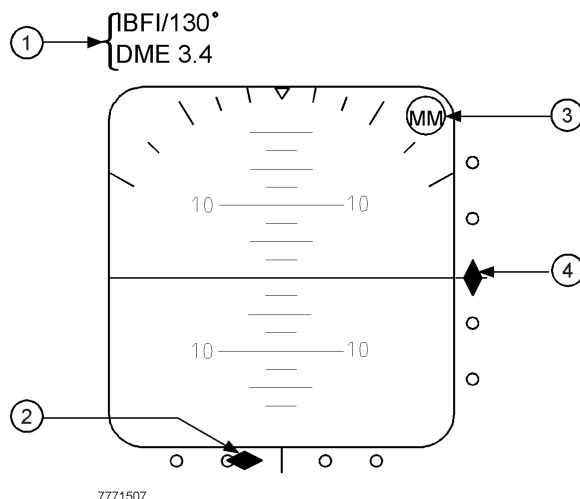
① Radio Altitude

Displays radio altitude below 2500 feet AGL.

The display box is highlighted in white for 10 seconds when passing below 2500 feet.

Turns amber when below radio altitude minimums.

PFD Instrument Landing System Indications



① Approach Reference

Displays the selected ILS identifier or frequency, approach front course, and ILS DME distance.

If the tuned ILS frequencies disagree, the frequency turns amber with an amber horizontal line through it.

If the approach courses in the ILS receivers disagree, the course turns amber with an amber horizontal line through it.

② Localizer Pointer and Scale

The localizer pointer:

- Indicates localizer position relative to the airplane
- Is in view when the localizer signal is received
- Fills in solid when within 2 1/2 dots from the center.

The scale is in view after the frequency is tuned.

At low radio altitudes, with the autopilot or flight director engaged, the scale turns amber and the pointer flashes to indicate excessive localizer deviation.

At low altitudes, with LNAV engaged and LOC armed, the localizer scale turns amber and the pointer flashes if the localizer is not captured.

③ Marker Beacon Indication

The marker beacon indication appears flashing when over one of the marker beacon transmitters:

- IM - An airway or inner marker beacon
- MM - A middle marker beacon
- OM - An outer marker beacon.

The indication flashes in cadence with the beacon identifier.

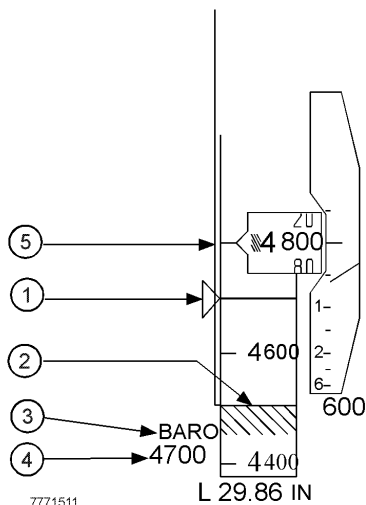
④ Glideslope Pointer and Scale

The glideslope pointer:

- Indicates glideslope position relative to the airplane, and:
- Is in view when the glideslope signal is received
- Fills in solid when within 2 1/2 dots from the scale center.

The scale is in view after the frequency is tuned.

At low radio altitudes, with the autopilot or flight director engaged, the scale turns amber and the pointer flashes to indicate excessive glideslope deviation.

PFD Landing Altitude/Minimums Indications**① BARO Minimums Pointer**

When BARO minimums are displayed, the number is also represented as a pointer and line on the altitude scale.

Turns steady amber when the airplane descends below baro minimums.

② Landing Altitude Indication

The crosshatched area indicates the FMC landing altitude for the destination runway or airport.

Indicates the landing altitude for the departure runway or airport until 400 NM or one-half the distance to the destination, whichever occurs first.

③ Minimums Reference

Displays BARO when the EFIS control panel MINS reference selector is set to BARO.

Displays RADIO when the EFIS control panel MINS reference selector is set to RADIO (no corresponding pointer or line on the altitude scale).

Turns amber and flashes for 3 seconds when the airplane descends below selected minimum altitude.

④ Minimums

Displays the approach minimums altitude set using the EFIS control panel MINS selector:

- BARO minimums are feet MSL
- RADIO minimums are radio altitude feet AGL.

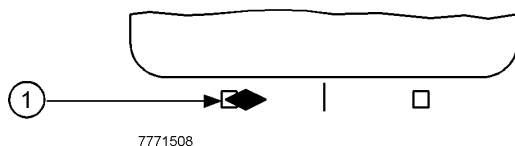
Turns amber and flashes for 3 seconds when the airplane descends below selected minimum altitude.

⑤ Landing Altitude Reference Bar

Indicates the height above touchdown.

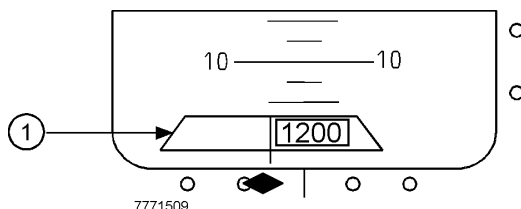
White bar - 500 to 1000 feet above landing altitude.

Amber bar - 0 to 500 feet above landing altitude.

PFD Expanded Localizer Indications**① Expanded Localizer Scale**

Displays when the autopilot or flight director is in LOC mode and the airplane is close to the runway center line. Provides a more sensitive display.

A rectangle equals 1/2 dot deviation.

PFD Rising Runway Indications**① Rising Runway**

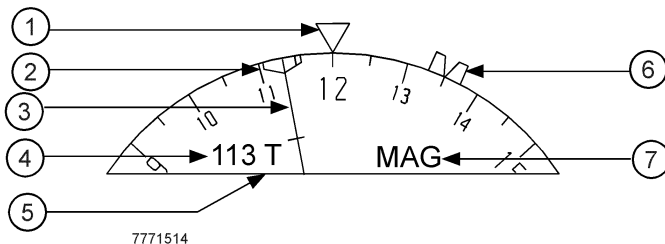
Displayed below 2500 feet radio altitude when the localizer pointer is in view for both front and back courses.

Moves toward the airplane symbol below 200 feet radio altitude.

The stem of the rising runway symbol flashes when localizer deviations cause the diamond to flash.

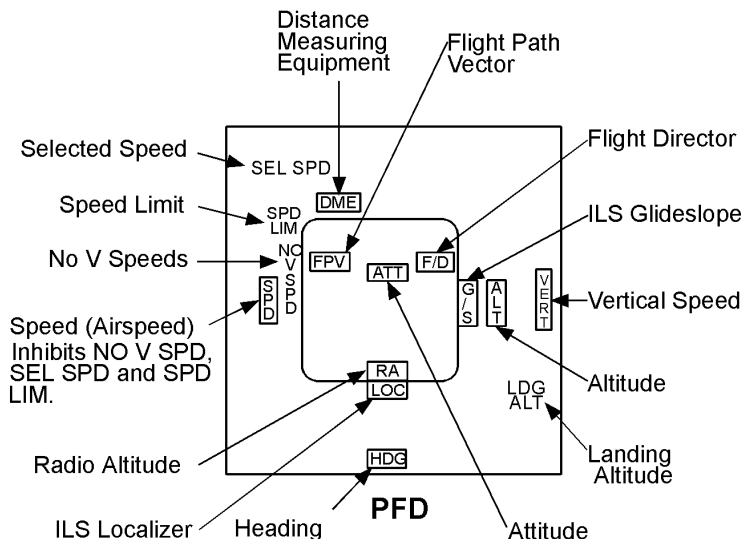
PFD Heading/Track Indications

Note: The selected track bug and selected heading bug are not displayed at the same time.



- ① **Current Heading Pointer**
Indicates current heading.
- ② **Selected Track Bug (MCP Selection)**
The selected track bug is displayed on the inside of the compass rose.
If selected track exceeds display range, the bug parks on the side of the compass rose in the direction of the shorter turn to the track.
- ③ **Track Line**
Indicates the current track.
- ④ **Selected Heading/Track (MCP Selection)**
Digital display of the selected heading or track bug.
- ⑤ **Selected Heading/Track Reference (MCP Selection)**
When HDG (heading) is selected, an H is displayed.
When TRK (track) is selected, a T is displayed.
- ⑥ **Selected Heading Bug (MCP Selection)**
The selected heading bug is displayed on the outside of the compass rose.
If selected heading exceeds display range, the bug parks on the side of the compass rose in the direction of the shorter turn to the heading.
- ⑦ **Heading/Track Reference**
Displays the automatic or manually selected heading/track reference:
 - MAG (magnetic north)
 - TRU (true north).

PFD Failure Flags



77715112

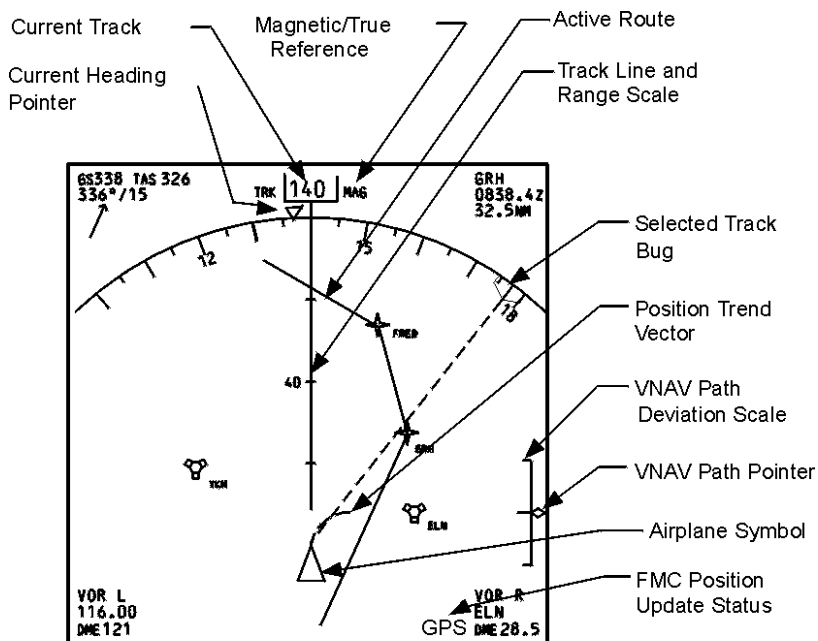
Note: PFD failure flags replace the appropriate display to indicate source system failure, or lack of computed information.

NAVIGATION DISPLAY (ND)

Note: Refer to the Navigation Display part of this section for a detailed explanation of the ND symbology shown on the following pages.

ND Map Mode

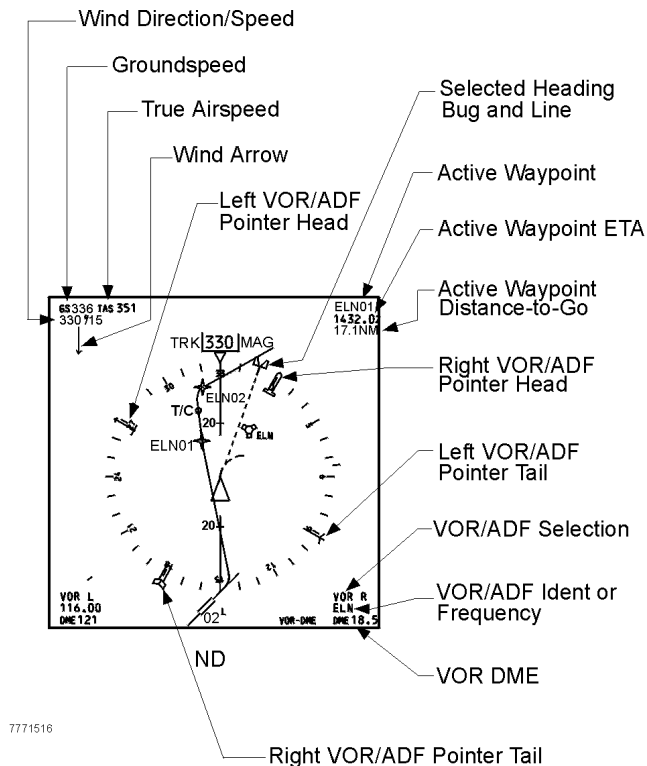
Expanded Map Mode



7771515

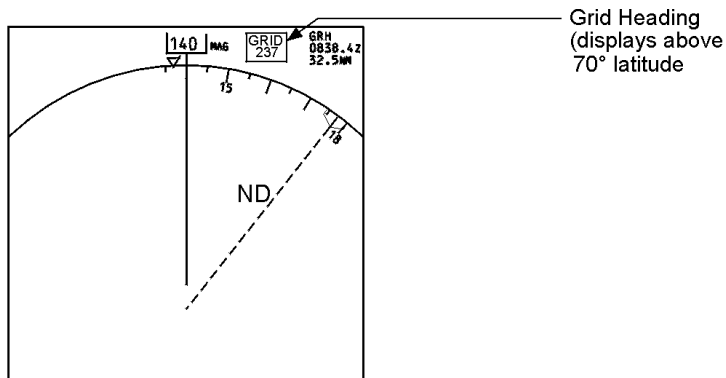
ND

Centered Map Mode



7771516

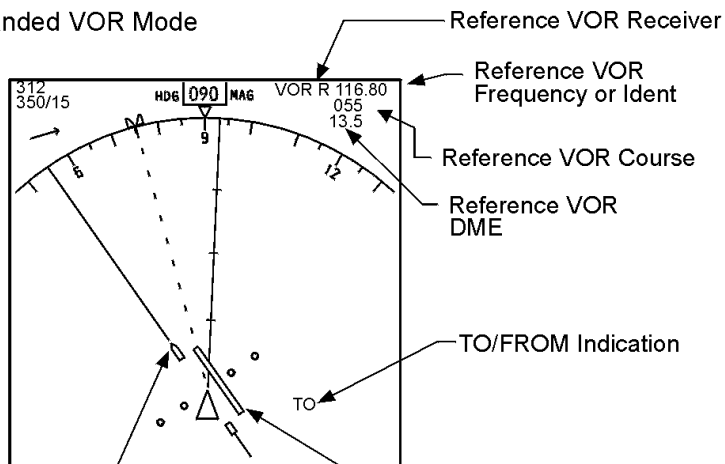
ND Grid Heading Display



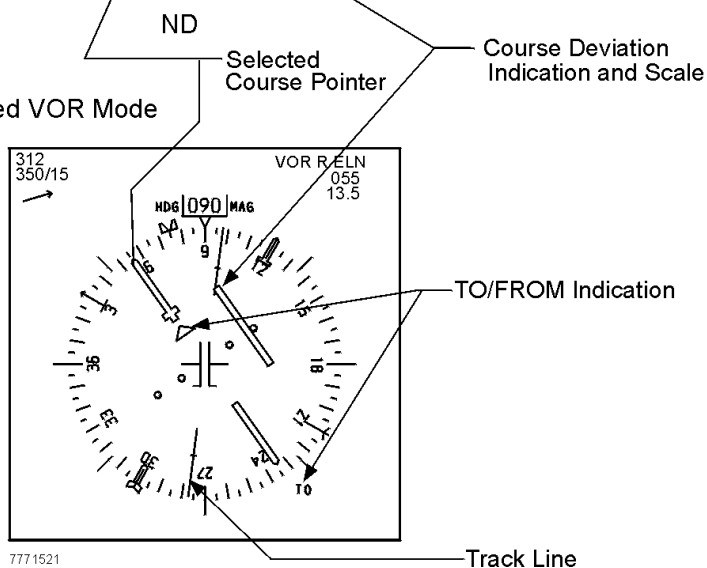
7771517

ND VOR Mode

Expanded VOR Mode



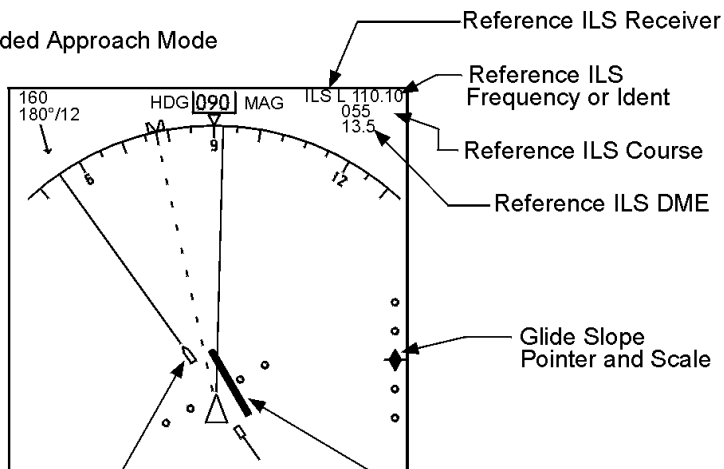
Centered VOR Mode



7771521

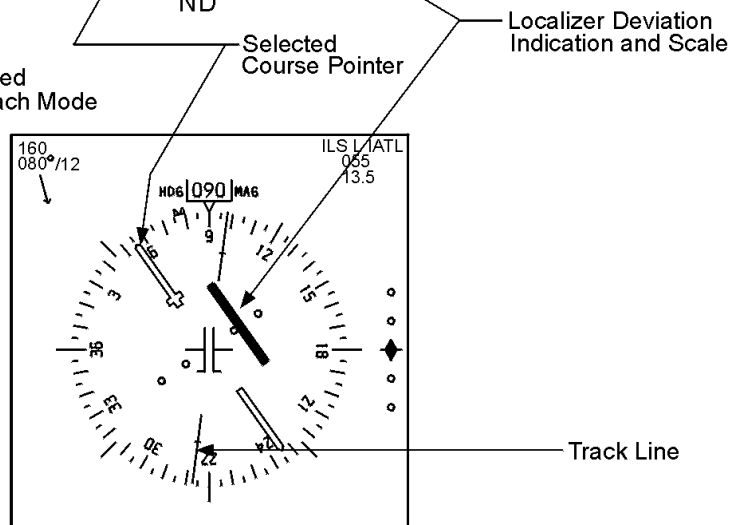
ND Approach Mode

Expanded Approach Mode

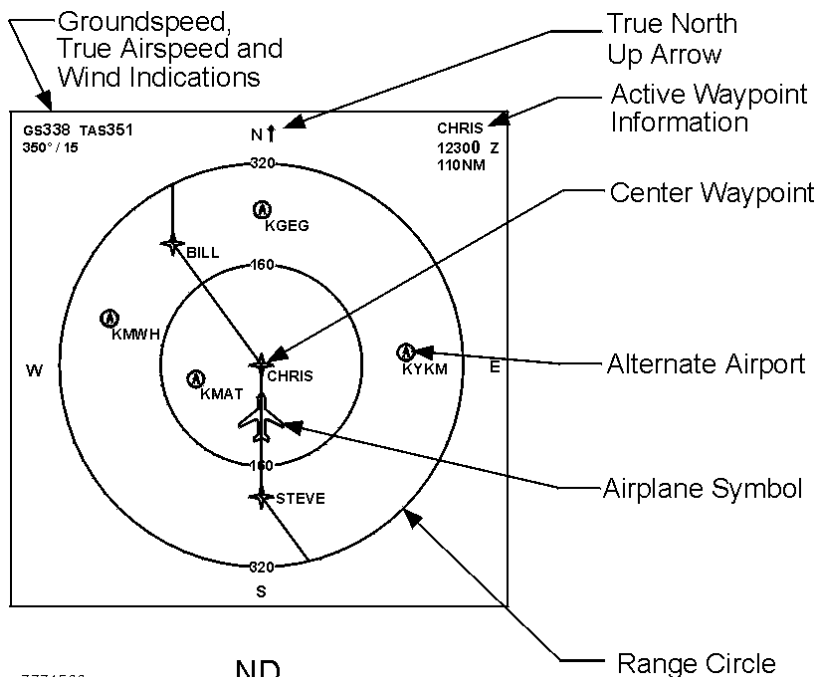


ND

Centered Approach Mode

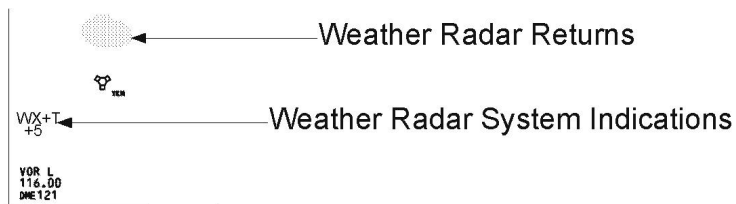


ND Plan Mode



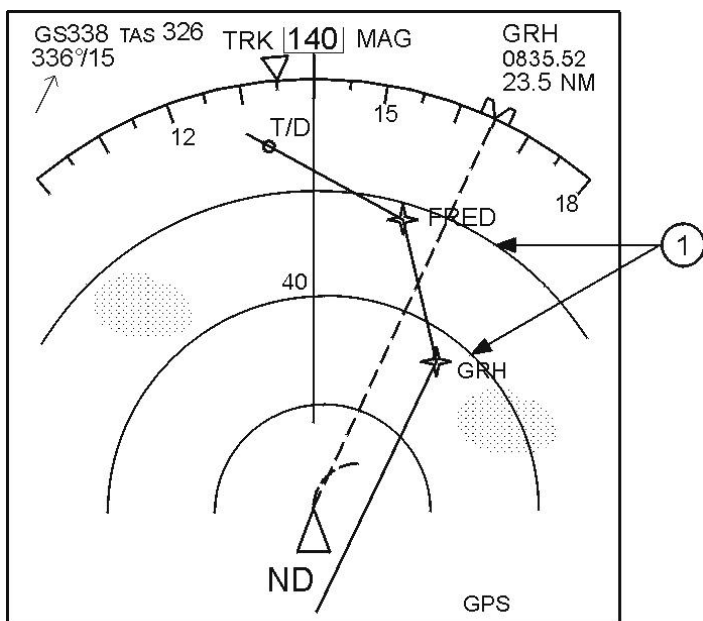
7771522

ND Weather Radar System Display Indications



7771518

ND

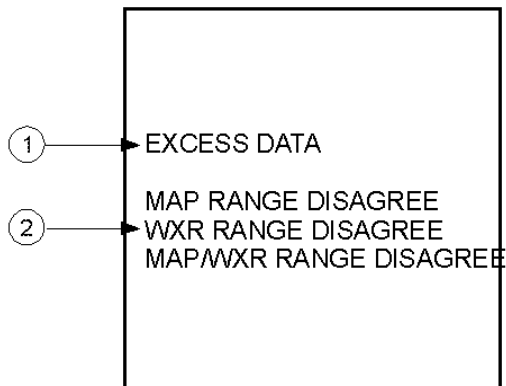


7771519

① TCAS/Weather Radar Range Arcs

Three range arcs in place of the range scale tics on map when TCAS or weather radar is selected.

ND Failure Messages



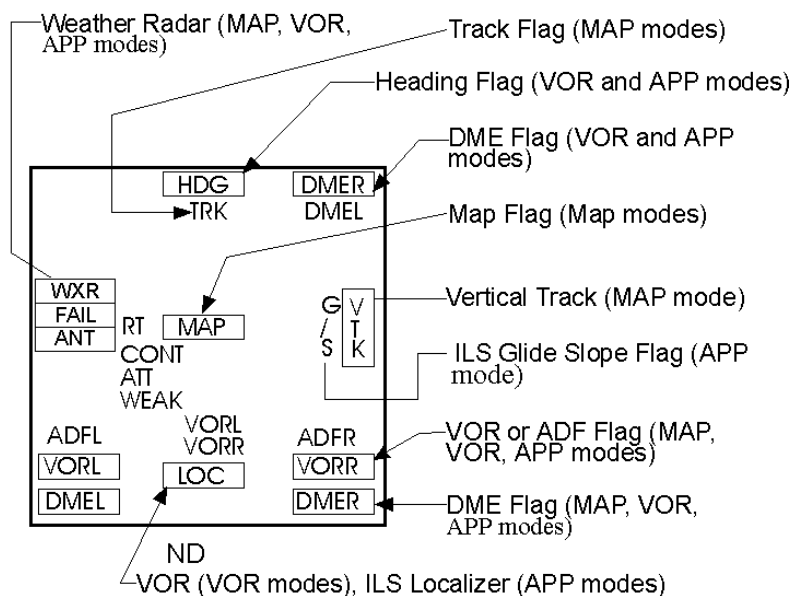
ND

7771523

- ① Excess Data
The amount of map information sent to the primary display system is too great to display.
- ② MAP/WXR Range Disagree
The selected range and range of display information disagree.
Map information is removed.

ND Failure Flags

Dashes replace numbers if there is no computed information. Failure flags replace symbols or failure messages are displayed, as appropriate. Flag location varies, depending on the ND mode selected.



777

Flight Manual

Continental

FLT INSTM DSP

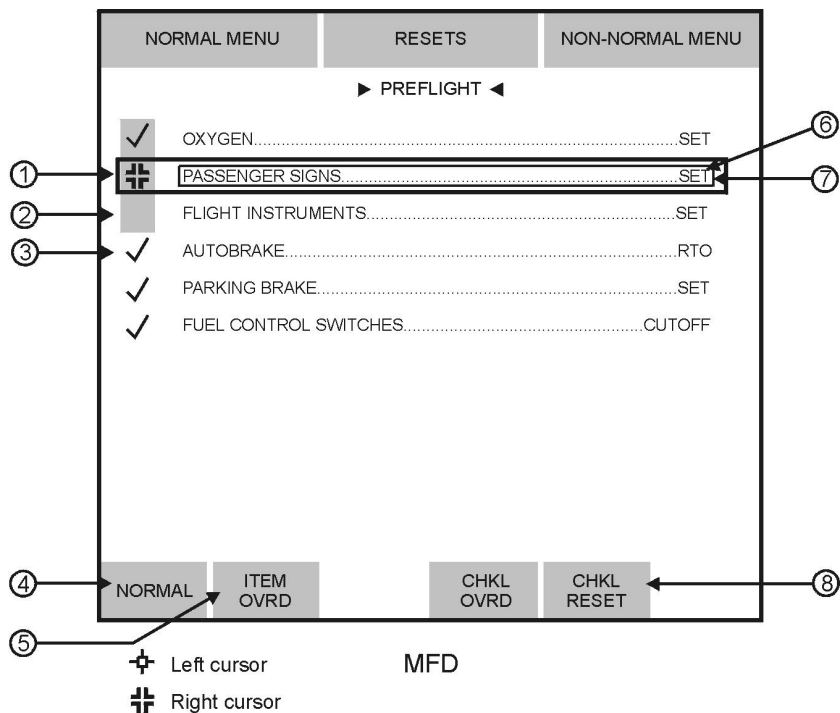
Sec. 6.10 Page 103

Rev. 11/01/01 #7

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ELECTRONIC CHECKLIST DISPLAYS

Normal Checklist



-
- ① **Cursor and Selection Box**
Highlights cursor selection area.
 - ② **Open Loop Indicator**
Indicates line item is an open loop action item. Requires crew confirmation to become complete.
 - ③ **Complete Indicator**
Indicates line item is complete.
 - ④ **Normal Checklist (NORMAL) Key**
Select -
 - Displays next incomplete normal checklist
 - Displays normal checklists menu page when all normal checklists are complete.Displayed (white) - Incomplete normal checklist has not been displayed.
Displayed (amber) - Incomplete normal checklist has been displayed but is not currently displayed.
 - ⑤ **Line Item Override (ITEM OVRD) Key**
Select - Overrides action item in current line item box. Item is displayed cyan.
 - ⑥ **Checklist Line Item**
Displayed (white) -
 - When action is required, line item is incomplete
 - When action is not required, line item remains white and is complete.Displayed (green) - Line item is complete.
Displayed (cyan) - Line item is inactive or overridden.
 - ⑦ **Current Line Item Box**
Highlights current incomplete line item.
 - ⑧ **Checklist Reset (CHKL RESET) Key**
Select - resets displayed checklist. All open loop line items become incomplete and current line item box, cursor selection box, and cursor move to first incomplete line item.

Non-Normal Checklist

NORMAL MENU	RESETS	NON-NORMAL MENU
HYD PRESS SYS C		
Center hydraulic system pressure is low.		1
✓ C1 OR C2 DEMAND PUMP SELECTOR.....ON		1
✓ If HYD PRESS SYS C message remains displayed:		3
✓ C2 PRIMARY PUMP SWITCH.....OFF		3
✓ C1 AND C2 DEMAND PUMP SELECTORS.....OFF		3
✓ GROUND PROXIMITY FLAP OVERRIDE SWITCH.....OVRD		3
NOTE: Inoperative items: - main landing gear hydraulic operation - main gear steering.		4
CONTINUED		
NORMAL	NOTES	CHKL OVRD
		CHKL RESET
		NON-NORMAL

77715103

MFD

- ① Previous Page Key
Select - Displays previous checklist page.
Displayed (gray) - Previous page is available.
Displayed (cyan) - Key is inactive. First page of checklist is displayed.
- ② Checklist Page Key
Select - Displays checklist page corresponding to page number on key.
Displayed (white) - Checklist page corresponding to page number on key is currently displayed.
Displayed (gray) - Checklist page corresponding to page number on key is not currently displayed.
- ③ Checklist Page Number
Displayed (white) - Checklist page is incomplete.
Displayed (green) - Checklist page is complete.

④ Next Page Key

Select - Displays next checklist page.

Displayed (gray) - Next page is available.

Displayed (cyan) - Key is inactive. Last page of checklist is displayed.

⑤ Non-Normal Checklist (NON-NORMAL) Key

Displayed when additional incomplete non-normal checklists exist.

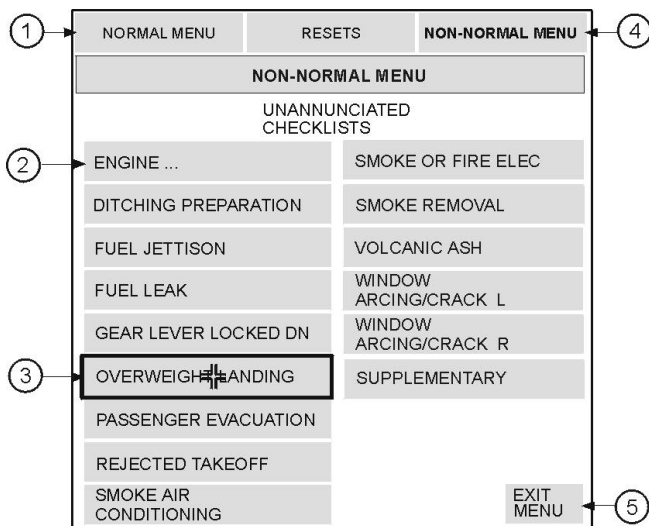
Select –

- Displays next incomplete non-normal checklist when one incomplete non-normal checklist exists
- Displays non-normal checklist queue when more than one incomplete non-normal checklist exists.

Displayed (white) - Incomplete non-normal checklist has not been displayed.

Displayed (amber) - Incomplete non-normal checklist has been displayed but is not currently displayed.

Checklists Menu Page

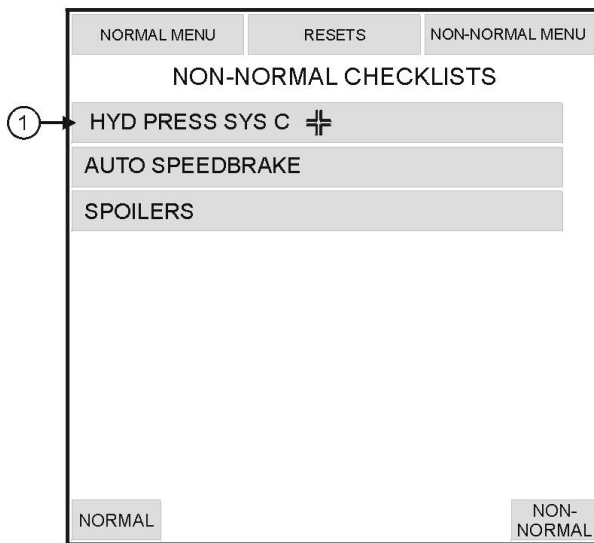


77715109

MFD

- ① **NORMAL MENU Key**
Select - Displays normal checklists menu page. Page contains checklist keys corresponding to the normal checklists.
- ② **Menu Key**
Indicated by three dots following menu title.
Select - Displays checklists menu page corresponding to title on key.
- ③ **Checklist Key**
Select - Displays checklist corresponding to title on key.
- ④ **NON-NORMAL MENU Key**
Select - Displays non-normal checklists menu page. Page contains menu keys corresponding to airplane systems.
- ⑤ **EXIT MENU Key**
Select - Exits page for access to the normal and non-normal checklist keys.

Non-Normal Checklist Queue



MFD

77715102

- ① Checklist Key
Select - displays checklist corresponding to title.

Resets Menu Page


NORMAL MENU	RESETS	NON-NORMAL MENU
RESETS		
AIRLINE DATABASE 3161-BFT-000-03	EFFECTIVE DATE	
BOEING DATABASE 3160-BFT-000-02		
RESET NORMAL		
RESET NON-NORMAL		
RESET ALL 		
EXIT MENU		

Diagram annotations: (1) points to the RESETS header; (2) points to the RESET ALL button; (3) points to the EXIT MENU button.

77715110

MFD

① Resets Menu (RESETS) Key

Select - Displays checklist resets page.

② Reset Key

Select - Resets checklists corresponding to title on key. All affected checklists become incomplete.

③ EXIT MENU Key

Select - Exits page for access to the normal and non-normal checklist keys.

Conditional Line Items

NORMAL MENU	RESETS	NON-NORMAL MENU
DET FIRE APU		
APU fire detectors are inoperative.		
①	→ If APU not running:	
	NOTE: Do not start the APU unless use is required.	
	→ If APU is running:	
<div style="border: 1px solid black; padding: 5px;"> <div style="display: inline-block; width: 20px; height: 20px; background-color: #ccc; text-align: center; line-height: 20px;">+</div> Plan to shut down the APU as soon as practical. </div>		

NORMAL MENU	RESETS	NON-NORMAL MENU
FLAPS DRIVE		
②	→ Flap position between 1 and 5 or at 5:	
	◆ YES	◆ NO
	NOTE: Use current flaps and VREF30 + 40 for landing.	
	→ Flap position between 5 and 20:	
	<div style="border: 1px solid black; padding: 5px;"> <div style="display: inline-block; width: 20px; height: 20px; background-color: #ccc; text-align: center; line-height: 20px;">+</div> <div style="display: inline-block; width: 40px; text-align: center;">◆ YES</div> <div style="display: inline-block; width: 40px; text-align: center;">◆ NO</div> </div>	
NOTE: Use current flaps and VREF 30 + 20 for landing.		
CONTINUED		
NORMAL	NOTES	CHKL OVRD
		CHKL RESET

▲

1

2

3

▼

① Closed Loop Conditional Line Items

Displayed (cyan) - Conditional line item is sensed false. All subsequent line items associated with the conditional line item become inactive and are displayed cyan. Current line item box, cursor selection box, and cursor skip inactive items and move to next incomplete line item.

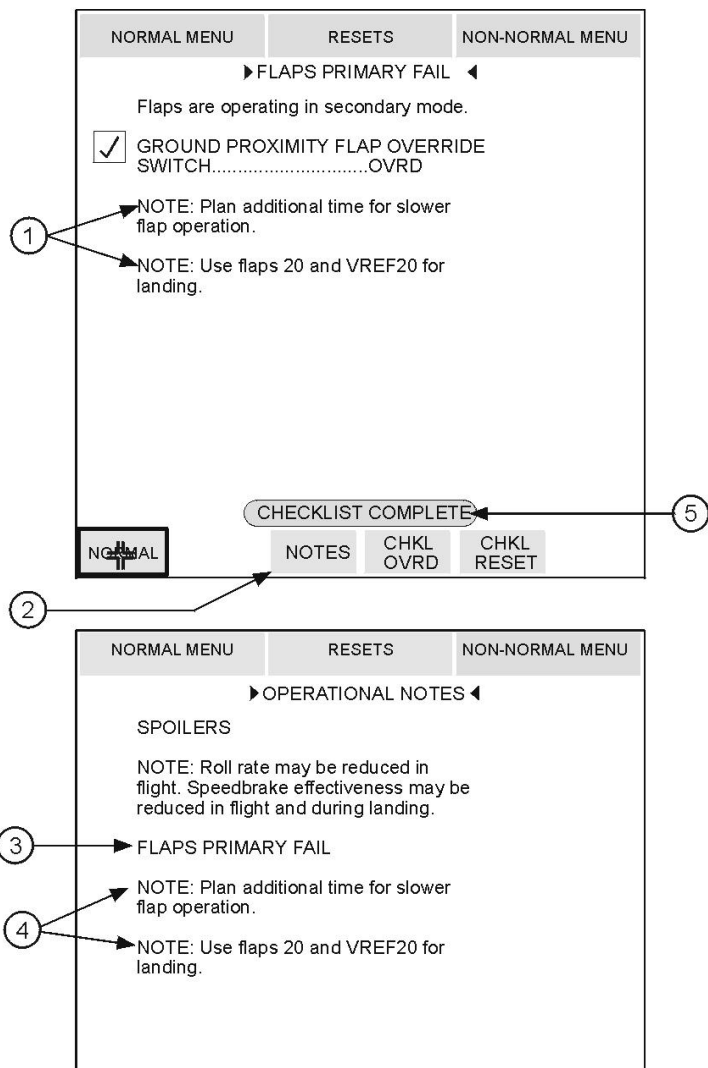
Displayed (green) - Conditional line item is sensed true. Current line item box, cursor selection box, and cursor move to next incomplete line item.

② Open Loop Conditional Line Items

Displayed (cyan) - Conditional line item is selected NO. All subsequent line items associated with the conditional line item become inactive and are displayed cyan. Current line item box, cursor selection box, and cursor skip inactive items and move to next incomplete line item.

Displayed (green) - Conditional line item is selected YES. Current line item box, cursor selection box, and cursor move to next incomplete line item.

Operational Notes



MFD

- ① Operational Notes
Shown in non-normal checklist.
- ② Operational Notes (NOTES) Key
Select - Displays operational notes page.
- ③ Checklist Reference
References non-normal checklist from which operational notes originated.
- ④ Operational Notes
Shown on operational notes page.
- ⑤ **CHECKLIST COMPLETE** Indicator
Displayed when all line items are either complete, inactive, or overridden, and all pages have been displayed.

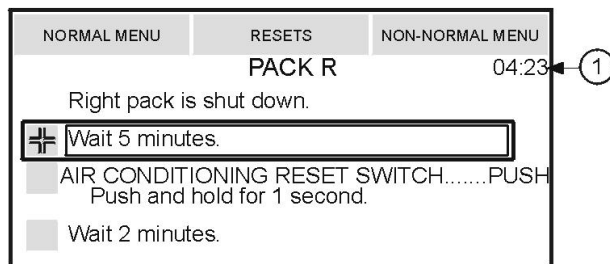
Deferred Line Items

NORMAL MENU	RESETS	NON-NORMAL MENU
FLAP/SLAT CONTROL		
NOTE: Use flaps 20 and VREF20 for landing.		
①	-----DEFERRED ITEMS-----	
②	==> APPROACH CHECKLIST	
③	<div style="border: 2px solid black; padding: 2px;"> <div style="display: flex; align-items: center;"> <div style="margin-right: 5px;">+</div> <div>ALTERNATE FLAPS ARM SWITCH.....ALTN</div> </div> </div>	
	<div style="display: flex; align-items: center;"> <div style="margin-right: 5px;">▶</div> <div>ALTERNATE FLAPS SELECTOR.....EXT Monitor airspeed during extension.</div> </div>	
④	CHECKLIST COMPLETE EXCEPT DEFERRED ITEMS	
NORMAL	ITEM OVRD	NOTES CHKL OVRD CHKL RESET

NORMAL MENU	RESETS	NON-NORMAL MENU
APPROACH		
✓	RECALL AND NOTES.....CHECKED	
✓	AUTOBRAKE....._	
✓	LANDING DATA.....SET	
✓	ALTIMETERS.....SET	
⑤	▶ FLAP/SLAT CONTROL	
⑥	<div style="border: 2px solid black; padding: 2px;"> <div style="display: flex; align-items: center;"> <div style="margin-right: 5px;">+</div> <div>ALTERNATE FLAPS ARM SWITCH.....ALTN</div> </div> </div>	
	<div style="display: flex; align-items: center;"> <div style="margin-right: 5px;">▶</div> <div>ALTERNATE FLAPS SELECTOR.....EXT Monitor airspeed during extension.</div> </div>	

- ① Deferred Line Items Separator
Separates deferred line items from non-normal checklist line items. All line items below separator are deferred.
- ② Checklist Reference
References normal checklist to which deferred line items are targeted.
- ③ Deferred Line Items
Shown in non-normal checklist.
- ④ **CHECKLIST COMPLETE EXCEPT DEFERRED ITEMS** Indicator
Displayed when all line items except deferred line items are either complete, inactive, or overridden, and all pages before the deferred line items separator have been displayed.
- ⑤ Checklist Reference
References non-normal checklist from which deferred line items originated.
- ⑥ Deferred Line Items
Shown in normal checklist.

Checklist Timer



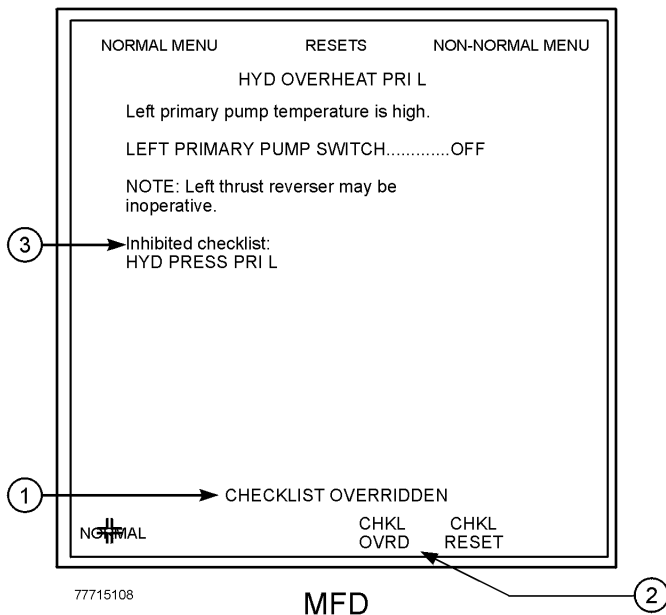
77715104

MFD

① Timer

Displays time remaining of time delay associated with line item in current line item box. If line item is complete, current line item box remains until timer expires.

Checklist Override / Inhibited Checklist



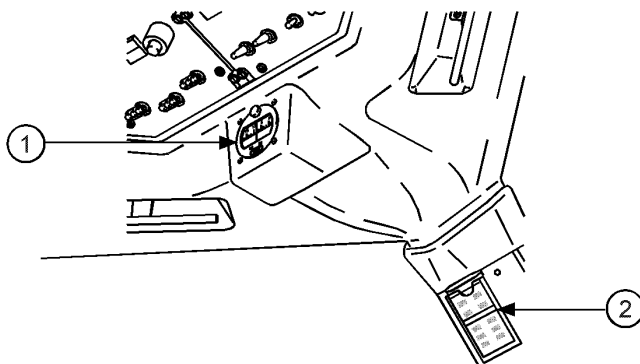
- ① **CHECKLIST OVERRIDDEN** Indicator
Displays when checklist is overridden. All line items are displayed cyan.
- ② **Checklist Override (CHKL OVRD) Key**
Select - Overrides displayed checklist.
- ③ **Inhibited Checklist(s) Line Item**
Lists consequential checklists which are inhibited or removed from the checklist queue and whose corresponding checklist icons are inhibited or removed from display.

STANDBY FLIGHT INSTRUMENTS / CLOCK

The standby flight instruments include the:

- Standby magnetic compass
- Standby attitude indicator
- Standby airspeed indicator
- Standby altimeter.

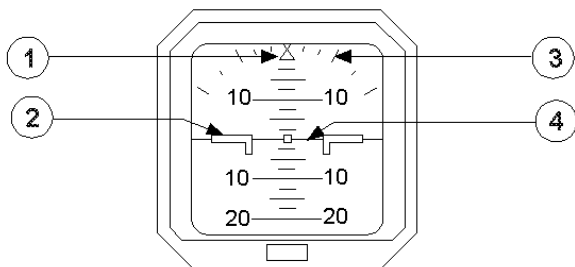
The standby attitude, airspeed, and altimeter indicators are small flat panel liquid crystal display units.

Standby Magnetic Compass**CENTER POST ABOVE GLARESHIELD**

7771534

- ① Standby Magnetic Compass
Displays magnetic heading.
- ② Standby Magnetic Compass Correction Card
Provides appropriate heading corrections.

Standby Attitude Indicator



CENTER FORWARD PANEL

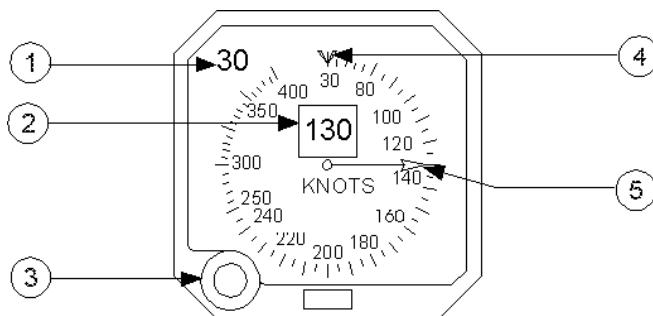
7771535

The standby attitude indicator displays SAARU attitude.

- ① Bank Pointer
Indicates airplane bank.
- ② Airplane Symbol
Indicates airplane attitude with reference to the SAARU horizon.
- ③ Bank Scale
Fixed reference for the bank pointer.
Scale marks are at 0, 10, 20, 30, 45, and 60 degrees.
- ④ Horizon Line and Pitch Scale
Indicates the SAARU horizon relative to the airplane symbol.
Pitch scale is in 2.5 degree increments.

Standby Airspeed Indicator

The standby airspeed indicator displays airspeed from a dedicated pitot and static air data module. The indicator does not use ADIRU or SAARU information.

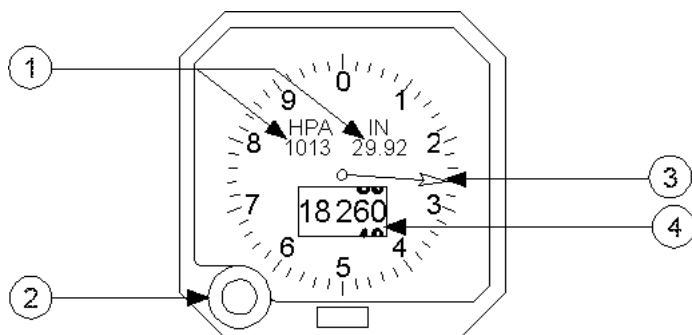


CENTER FORWARD PANEL

7771536

- ① Selected Speed-Displays the speed selected with the bug selector and indicated by the standby airspeed bug.
- ② Current Standby Airspeed - Displays current airspeed.
- ③ Standby Airspeed Bug Selector
Rotate (outer) - Adjusts the standby airspeed bug.
Push (inner) - Turns the standby airspeed display bug off and on.
- ④ Standby Airspeed Bug
Points to the speed selected with the bug selector.
- ⑤ Current Standby Airspeed Pointer
Indicates current airspeed.

Standby Altimeter



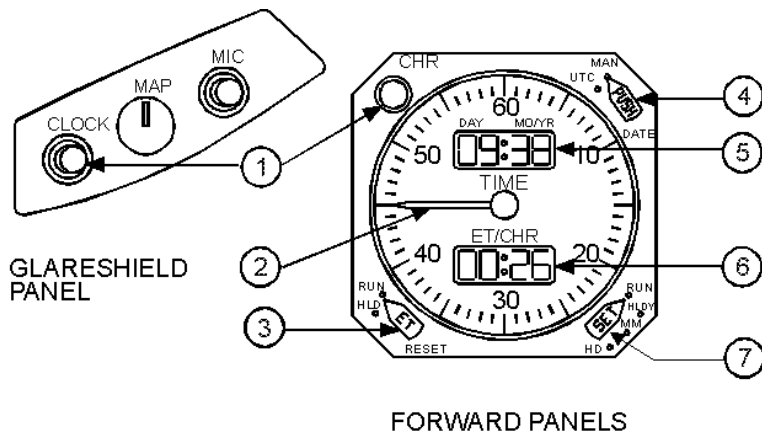
CENTER FORWARD PANEL

7771537

The standby altimeter displays barometric altitude from a dedicated air data module.

- ① Barometric Reference
Indicates the selected barometric reference in inches (IN) and Hectopascals (HPA).
- ② Standby Barometric Selector
Rotate (outer) - Adjusts the altimeter barometric reference.
Push (inner) - Switches between standard and the last selected barometric reference.
- ③ Altitude Pointer
Indicates barometric altitude in hundreds of feet.
One full rotation of the pointer is 1000 feet.
- ④ Current Altitude
Indicates barometric altitude.

Clock



7771538

- ① Chronograph (CHR or CLOCK) Switch
Push - Subsequent pushing starts, stops, resets the chronograph.
- ② Chronograph Pointer
Indicates chronograph seconds.
- ③ Elapsed Time (ET) Selector
Controls the elapsed time function.
RESET - Blanks ET display (spring loaded to HLD).
HLD (hold) - Stops the elapsed time display.
RUN - Starts the elapsed time display.
- ④ Time/Date Selector
MAN (Manual) - The clock is manually set to a time and date.
UTC - The clock is automatically set to the UTC date and time.
Push -
 - Alternately displays the day-month, then year in the time/date window
 - Subsequent selection displays only the time in the time/date window.

⑤ Time/Date Window

Displays time (hours, minutes) when time is selected on the time/date selector.

Alternately displays day-month and year when date is selected on the time/date selector.

⑥ Elapsed Time (ET)/Chronograph (CHR) Window

Displays elapsed time (hours, minutes) or chronograph minutes.

The chronograph display replaces the elapsed time display.

Elapsed time continues to run in the background and will be displayed after the chronograph is reset.

⑦ Clock Set Selector

Sets the time and date when the time/date selector is set to manual.

HD (Hours, Day) -

- Advances hours when time is selected on the time/date selector
- Advances days when date is selected on the time/date selector.

MM (Minutes, Month) -

- Advances minutes when time is selected on the time/date selector
- Advances months when date is selected on the time/date selector.

HLDY (Hold, Year) -

- Stops the time indicator and sets the seconds to zero when time is selected on the time/date selector
- Advances years when date is selected on the time/date selector.

RUN - Starts the time indicator.

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EICAS MESSAGES

Note: The **OVERSPEED** warning and the **ALTITUDE ALERT** caution messages are covered in Section 6.15, Warnings.

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
ALTN ATTITUDE	Advisory		Both AIR DATA/ATTITUDE source switches are in the ALTN position.
BARO SET DISAGREE	Advisory		Captain's and first officer's barometric settings disagree.
DISPLAY SELECT PNL	Advisory		Left, center, or right CDU control of the display select panel is active.
EFIS CONTROL PNL L, R	Advisory		EFIS control panel is inoperative or CDU control of the EFIS control panel is active.
SGL SOURCE AIR DATA	Advisory		Both PFDs are receiving air data from the same single channel source.
SGL SOURCE DISPLAYS	Caution	Beeper	A single source of display information is being used by some or all display units.
SGL SOURCE RAD ALT	Advisory		Both PFDs are using the same source for radio altimeter information.
SINGLE SOURCE F/D	Advisory		Both PFDs are using the same source for flight director information.
VMO GEAR DOWN	Memo		V _{mo} value set for dispatch with landing gear extended.

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LIST OF EFFECTIVE PAGES

PAGE	DATE	PAGE	DATE	PAGE	DATE	
TOC-1	11/01/01	30	11/01/01	62	11/01/01	
TOC-2	11/01/01			63	11/01/01	
TOC-3	11/01/01	31	11/01/01	64	11/01/01	
TOC-4	11/01/01	32	11/01/01	65	11/01/01	
		*	33	11/01/02	66	11/01/01
1	11/01/01	34	11/01/01	67	11/01/01	
2	11/01/01	35	11/01/01	68	11/01/01	
3	11/01/01	36	11/01/01	69	11/01/01	
4	11/01/01	37	11/01/01	70	11/01/01	
5	11/01/01	38	11/01/01			
6	11/01/01	39	11/01/01	71	11/01/01	
7	11/01/01	40	11/01/01	72	11/01/01	
8	11/01/01			73	11/01/01	
9	11/01/01	41	11/01/01	74	11/01/01	
10	11/01/01	*	42	11/01/02	75	11/01/01
		*	43	11/01/02	76	11/01/01
11	11/01/01	*	44	11/01/02	77	11/01/01
12	11/01/01	*	45	11/01/02	78	11/01/01
13	11/01/01	*	46	11/01/02	79	11/01/01
14	11/01/01	47	11/01/01	80	11/01/01	
15	11/01/01	*	48	11/01/02		
16	11/01/01	*	49	11/01/02	81	11/01/01
17	11/01/01	*	50	11/01/02	82	11/01/01
18	11/01/01			83	11/01/01	
19	11/01/01	*	51	11/01/02	84	11/01/01
20	11/01/01	*	52	11/01/02	85	11/01/01
		53	11/01/01	86	11/01/01	
21	11/01/01	54	11/01/01	87	11/01/01	
22	11/01/01	55	11/01/01	*	88	11/01/02
23	11/01/01	56	11/01/01	89	11/01/01	
24	11/01/01	57	11/01/01	90	11/01/01	
25	11/01/01	58	11/01/01			
26	11/01/01	59	11/01/01	91	11/01/01	
* 27	11/01/02	60	11/01/01	92	11/01/01	
28	11/01/01			93	11/01/01	
29	11/01/01	61	11/01/01	94	11/01/01	

* Asterisk indicates page(s) revised or added by the current revision.

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NAVIGATION SYSTEM DESCRIPTION

INTRODUCTION

Navigation systems include Global Positioning System (GPS), Air Data Inertial Reference System (ADIRS), VOR, DME, ILS, ADF, ATC transponder, weather radar, and the Flight Management System (FMS). The FMS is described in the Flight Management System Description in this section.

NAVIGATION SYSTEMS FLIGHT INSTRUMENT DISPLAYS

Refer to Section 6.10, Flight Instruments, Displays for flight instrument display system operations and typical instrument displays.

GLOBAL POSITIONING SYSTEM (GPS)

Left and right GPS receivers are independent and supply very accurate geographical data to the FMC. All GPS tuning is automatic.

GPS Displays

POS REF 3/3 page shows the left and right GPS position. The ND annunciates GPS when the FMC uses GPS position updates.

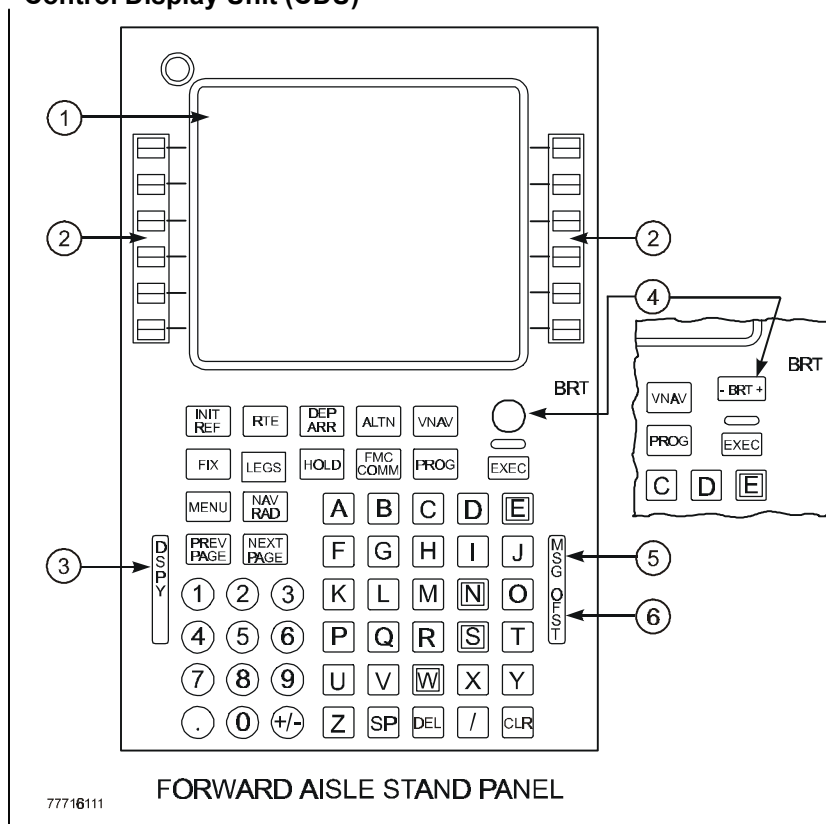
When the POS (position) switch on the EFIS control panel is selected, the ND map shows the left and right GPS symbols. The GPS symbols are identical and show as a single symbol when the GPS receivers calculate the same position.

GPS Data

If the ADIRU becomes inoperative during flight, the EICAS shows the message **NAV ADIRU INERTIAL** and the FMC uses only GPS data to navigate.

Use the **GPS NAV** prompt on the POS REF page to inhibit GPS navigation data. The EICAS message **GPS** alerts the crew when data from both GPS systems are unavailable or when both systems have failed.

Control Display Unit (CDU)



- ① Control Display Unit (CDU) Display
Shows FMS data pages
- ② Line Select Keys
Push –
 - moves data from scratchpad to selected line
 - moves data from selected line to scratchpad
 - selects page, procedure, or performance mode as applicable
 - deletes data from selected line when **DELETE** is shown in scratchpad

Conventions –

- scratchpad must be blank for line select transfer
- data cannot be transferred to a blank line
- a blank scratchpad can not be transferred to a line
- not all data can be modified
- message displays if inappropriate entries attempted

③ Display (**DSPY**) Light

Illuminated (white) –

- when RTE page 3 or greater, RTE LEGS page 2 or greater, RTE DATA page 2 or greater is shown
- when airplane is not in holding pattern shown on HOLD page
- when modification is in progress, and any RTE, RTE LEGS, RTE DATA, HOLD, or VNAV page is shown

④ Brightness Control

Rotate – controls display brightness

On some aircraft:

Push –

- “+” increases brightness
- “-” decreases brightness
- 24 segment light brightness bar displays in the scratchpad and remains displayed for 2 seconds after release of the + or – push. Existing scratchpad information is saved and displays following fade of the brightness bar.

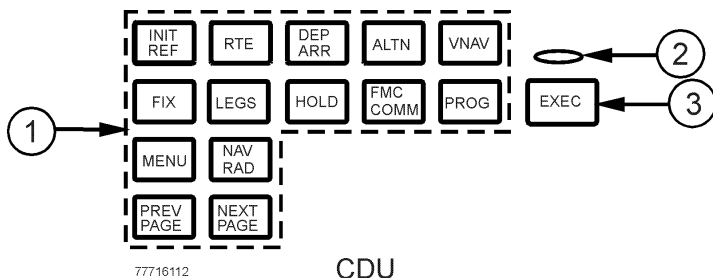
⑤ Message (**MSG**) Light

Illuminated (white) –

- scratchpad displays message
- pushing CLEAR key extinguishes light and clears message

⑥ Offset (**OFST**) Light

Illuminated (white) – LNAV gives guidance for lateral route offset

Function and Execute Keys**① CDU Function Keys**

Push –

- INT REF – shows page for data initialization or for reference data
- RTE – shows page to input or change origin, destination, or route
- DEP ARR – shows page to input or change departure and arrival procedures
- ALTN – shows page to modify destination and route for alternate diversion
- VNAV – shows page to view or change vertical navigation path data
- FIX – shows page to create reference points on ND map
- LEGS –
 - Shows page to evaluate or modify lateral and vertical route data
 - Show page to control ND PLAN mode display
- HOLD – shows page to create holding patterns and show holding pattern data
- FMC COMM – shows FMC data link status page
- PROG – shows page to view dynamic flight and navigation data, including waypoint and destination ETAs, fuel remaining, and arrival estimates
- MENU – shows page to choose subsystems controlled by CDU
- NAV RAD – shows page to monitor or control navigation radio tuning

- PREV PAGE – shows previous page of related pages (for example, LEGS pages)
- NEXT PAGE – shows next page of related pages

② Execute Light

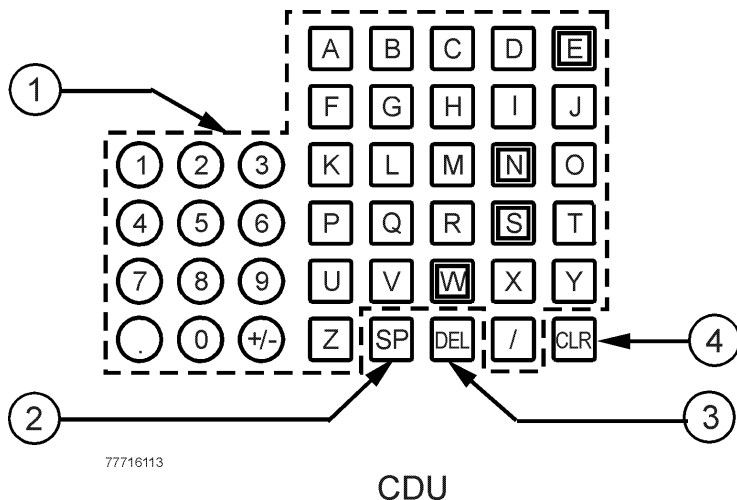
Illuminated (white) – active data is modified but not executed

③ Execute (EXEC) Key

Push –

- Makes data modification(s) active
- Extinguishes execute light

Alpha/Numeric and Miscellaneous Keys



① Alpha/Numeric Keys

Push –

- Puts selected character in scratchpad
- Slash (/) key – puts “/” in scratchpad
- Plus Minus (+/-) key – first push puts “-” in scratchpad. Subsequent pushes alternate between “+” and “-”.

② Space (SP) Key

Push –

- Puts space in scratchpad
- Puts underscore character “_” in scratchpad when CDU is used as input device for systems other than FMC

③ Delete (DEL) Key

Push – puts “DELETE” in scratchpad

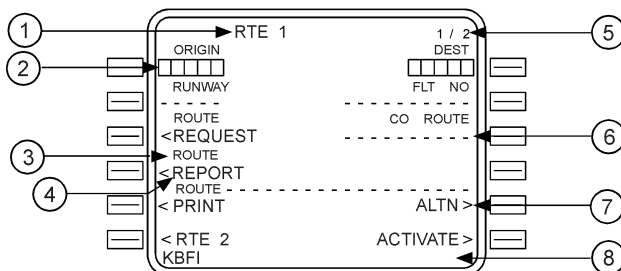
④ Clear (CLR) Key

Push –

- Clears last scratchpad character
- Clears scratchpad message

Push and hold – clears all scratchpad data

CDU Page Components



CDU

77716114

- ① **Page Title**
Subject or name of data shown on page
ACT (active) or MOD (modified shows whether page contains active or modified data
- ② **Boxes**
Data input is mandatory
- ③ **Line Title**
Title of data on line below
- ④ **Line**
Shows –
 - Prompts
 - Selectors
 - Data associated with line title.
 Large font indicates crew entered or verified data. Small font indicates FMC computed data.
- ⑤ **Page Number**
Left number is page number. Right number is total number of related pages. Page number is blank when only one page exists.
- ⑥ **Dashes**
Data input is optional. The data is not mandatory.

⑦ Prompts

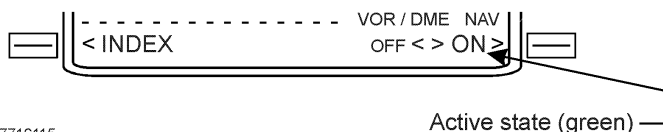
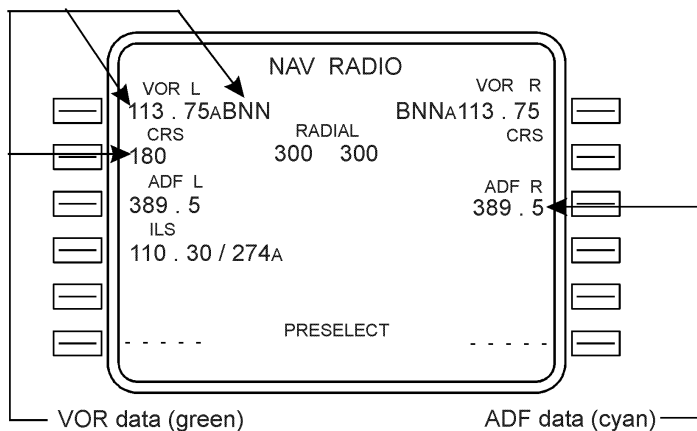
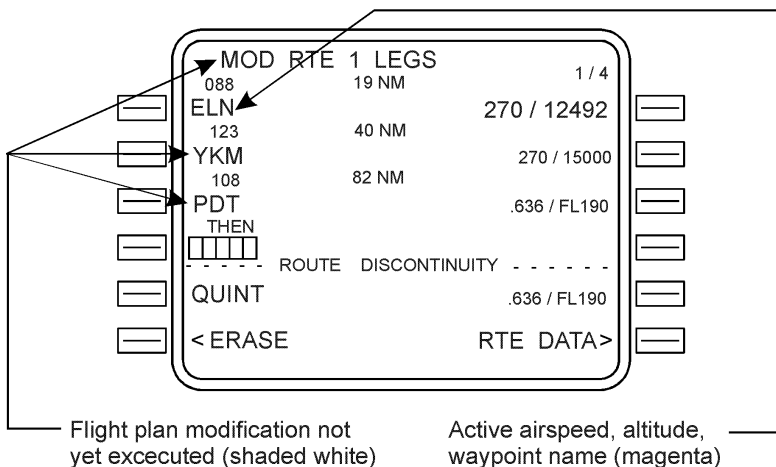
Show pages, select modes, and control displays. Caret “<” or “>” is before or after prompt.

⑧ Scratchpad

Shows messages, alphanumeric entries or line selected data.

INTENTIONALLY LEFT BLANK

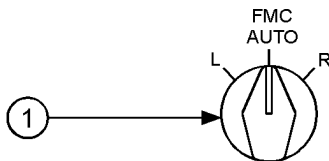
CDU Page Color



Color is used as follows:

- Black – background color of page
- Cyan –
 - ADF frequencies
 - inactive RTE page title
- Green –
 - navigation radio data
 - active state of two-position and three-position selectors
- Magenta – data used by FMC for lateral and vertical flight commands
 - active waypoint
 - active airspeed
 - active altitude
- Shaded white –
 - modifications
 - mod precedes page titles of modified pages
- White – most data

FMC Selector



RIGHT FOWARD PANEL

77716116

①

FMC Selector

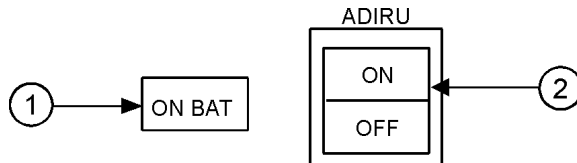
L – selects left FMC to provide guidance commands

AUTO – automatically selects other FMC if one FMC fails

R – selects right FMC to provide guidance commands

INERTIAL SYSTEM

Air Data Inertial Reference Unit (ADIRU)



OVERHEAD PANEL

77716117

①

On Battery (**ON BAT**) Light

Illuminated (white) – airplane battery powers ADIRU

Note: **ON BAT** light illuminates only when ADIRU has been aligned on airplane or ground power, and primary power is subsequently removed or failed (battery power only remains).

②

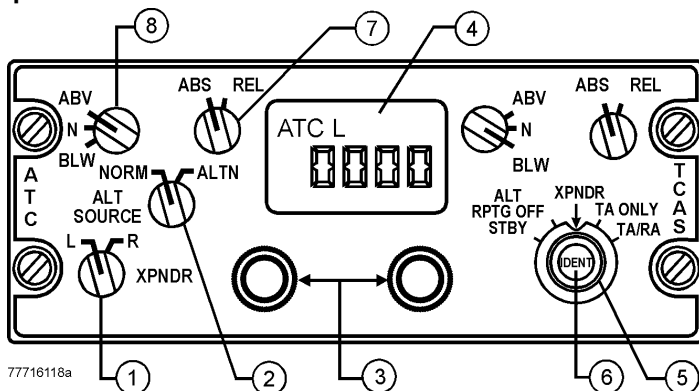
ADIRU Switch

ON – applies power to ADIRU

OFF – removes power when airspeed is less than 30 knots

RADIO NAVIGATION SYSTEMS

Transponder Panel



- ① Transponder (XPNDR) Selector
L or R – selects desired transponder.
- ② Altitude (ALT) SOURCE Selector
NORM (normal) – selects ADIRU as source of transponder altitude reporting.
ALTN (alternate) – selects SAARU as source for transponder altitude reporting.
- ③ Transponder Code Selectors
Rotate – Sets transponder code in transponder.
- ④ Transponder Code Window
Shows transponder code.
Shows operating transponder (L or R).
- ⑤ Transponder Mode Selector
STBY (standby) – does not transmit.
ALT RPTG (altitude reporting) OFF – transponder operates without altitude reporting.
XPNDR (transponder) – activates transponder with altitude reporting when airplane is in flight.
TA (traffic advisory) ONLY and TA/RA (resolution advisory) – Refer to Chapter 6.15, Warnings.

⑥ Identification (IDENT) Switch

Push – transmits an identification signal

⑦ Absolute/Relative (ABS-REL switch)

This 2- position rotary switch selects a flight level mode of operation. The two ABS/REL switches are located to the left and to the right of the control panel. The purpose of a dual switch is to independently control the left and right VSI/TCAS displays.

⑧ ABV-N-BLW

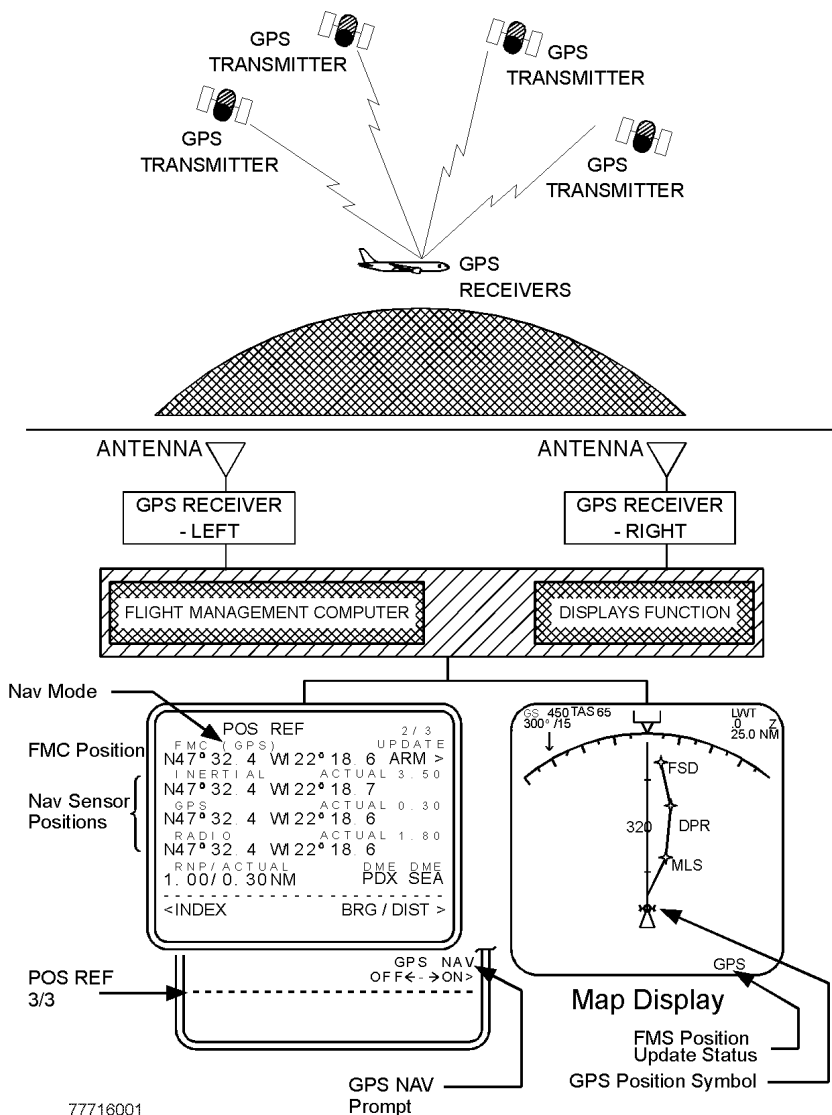
This 3-position switch provides control of the altitude range for traffic advisory. There are two ABV-N-BLW switches located to the left of the control panel. Selections of the left switch are intended to control the left VSI/TCAS display, while the switch on the right side of the control panel control outputs to the right VSI/TCAS display.

ABV – altitude range is set to 7000 ft. above the aircraft, and 2700 ft. below the aircraft

N - altitude range is set to 2700 ft. above the aircraft, and 2700 ft. below the aircraft

BLW - altitude range is set to 7000 ft. below the aircraft, and 2700 ft. above the aircraft

GPS System Schematic



INERTIAL SYSTEM

Air Data Inertial Reference System (ADIRS)

The ADIRS calculates airplane position, speed, altitude, and attitude data for the displays, flight management system, flight controls, engine controls, and other systems. The major components of ADIRS are the air data inertial reference unit (ADIRU), secondary attitude and air data reference unit (SAARU), and air data modules.

Air Data Inertial Reference Unit (ADIRU)

The ADIRU supplies primary flight data, inertial reference, and air data. The ADIRU is fault-tolerant and fully redundant.

ADIRU Power

Initial power-up requires battery bus power and the ADIRU switch to be ON. If the ADIRU is switched OFF, it must complete a full realignment cycle before the airplane can be moved.

If electrical power is subsequently removed from the airplane and the BATTERY switch is switched OFF, the hot battery bus continues to supply electrical power to the ADIRU. The **ON BAT** light illuminates, and the horn in the landing gear wheel well sounds to alert maintenance personnel the ADIRU is on battery power.

When the ADIRU switch is OFF, the ADIRU remains powered for a few seconds.

In flight, system logic prevents the ADIRU from becoming unpowered if the ADIRU switch is inadvertently switched OFF.

ADIRU Alignment

On initial power-up, the ADIRU enters the align mode. The EICAS shows the memo message **ADIRU ALIGN MODE**. Attitude or heading/track data is removed from the PFDs. Airplane latitude/longitude position must be entered on the CDU POS INIT page. The airplane should not move until alignment is complete.

If the latitude/longitude position is not close to the position of the origin airport, the CDU shows the scratchpad message **INERTIAL/ORIGIN DISAGREE**. If the crew-entered latitude/longitude position does not pass internal ADIRU comparison tests, the CDU shows the scratchpad message **ENTER INERTIAL POSITION**.

If a new airplane present position entry fails the internal check twice, the CDU shows the scratchpad message **ALIGNMENT REINITIATED**. The system automatically starts a new alignment cycle.

In rare cases, a position update of the ADIRU may cause the EICAS to momentarily show the message **NAV UNABLE RNP**. This occurs if the entered ADIRU position is far different than the GPS position. The message displays until the FMC reconciles the difference between the new ADIRU position and the GPS position.

When the alignment is complete, the ADIRU changes to the navigate mode and the airplane can be moved. If the airplane stops for an extended period, the ADIRU changes to the automatic realign mode and refines the alignment until the airplane moves again.

In the automatic realign mode, ADIRU velocity and acceleration errors are reset to zero. The inertial position can be manually updated when the ADIRU is in the automatic realign mode by entering a new latitude/longitude position on the POS INIT 1/3 page. The ADIRU cannot be realigned in flight.

Note: A complete ADIRU alignment is recommended if the total time in the navigation mode is expected to exceed 24 hours.

Secondary Attitude and Air Data Reference Unit (SAARU)

The SAARU is a secondary source of critical flight data for displays, flight control systems, and other systems. If the ADIRU fails, the SAARU automatically supplies attitude, heading, and air data. SAARU heading must be manually indexed to the magnetic heading periodically.

If ADIRU inertial data fails, the EICAS caution message **NAV ADIRU INERTIAL** displays. The SAARU supplies attitude data to the PFD and three minutes of backup heading. The heading is based on ADIRU heading prior to failure. The CDU POS INIT page shows the **SET HDG** prompt three minutes after ADIRU failure. Use the **SET HDG** prompt to set the SAARU heading to the magnetic heading. SAARU heading must be periodically updated. SAARU heading is provided until the airplane decelerates below 100 knots. There are no other prompts to remind the crew to enter or to update the SAARU heading.

The following functions are inoperative after failure of the inertial reference portion of the ADIRU:

AFDS Modes:

- LNAV
- VNAV
- TO/GA
- LOC
- GS
- FPA
- TRK HOLD / SEL
- HDG HOLD / SEL*

Navigation Functions:

- FMC VNAV pages
- FMC Performance Predictions
- ND Wind Direction and Speed (wind arrow)

PFD Functions:

- Flap Maneuver Speeds
- PFD Heading*

Note: * This function is operative when airplane heading is entered on the POS INIT page.

Note: If the airplane is in the polar region when the ADIRU fails, SAARU backup heading for three minutes is not provided.

Note: ND map mode display following ADIRU failure references TRK.

Note: Autobrakes are also inoperative.

The following additional functions are inoperative after failure of the inertial reference portion of the ADIRU and loss of GPS information:

- ND Map (center and expanded)
- CDU active leg course and distance
- CDU direct-to a waypoint
- FMC Alternate Airport DIVERT NOW
- FMC navigation radio autotuning

FMC navigation data is still available when the ADIRU fails. Restoration of the SAARU heading allows navigation in the ND VOR mode using radio navigation data.

The SAARU supplies the only source of attitude data to the standby attitude indicator display.

SAARU power-up is completely automatic at airplane power-up. There are no SAARU controls.

Air Data and Attitude Sources

The ADIRU and SAARU receive air data from the same three sources. The ADIRU and SAARU validate the air data before it may be used for navigation.

The three air data sources, or channels, are the left, center, and right pitot tube and static systems. Air data is valid when two or more sources agree in the ADIRU, SAARU or both.

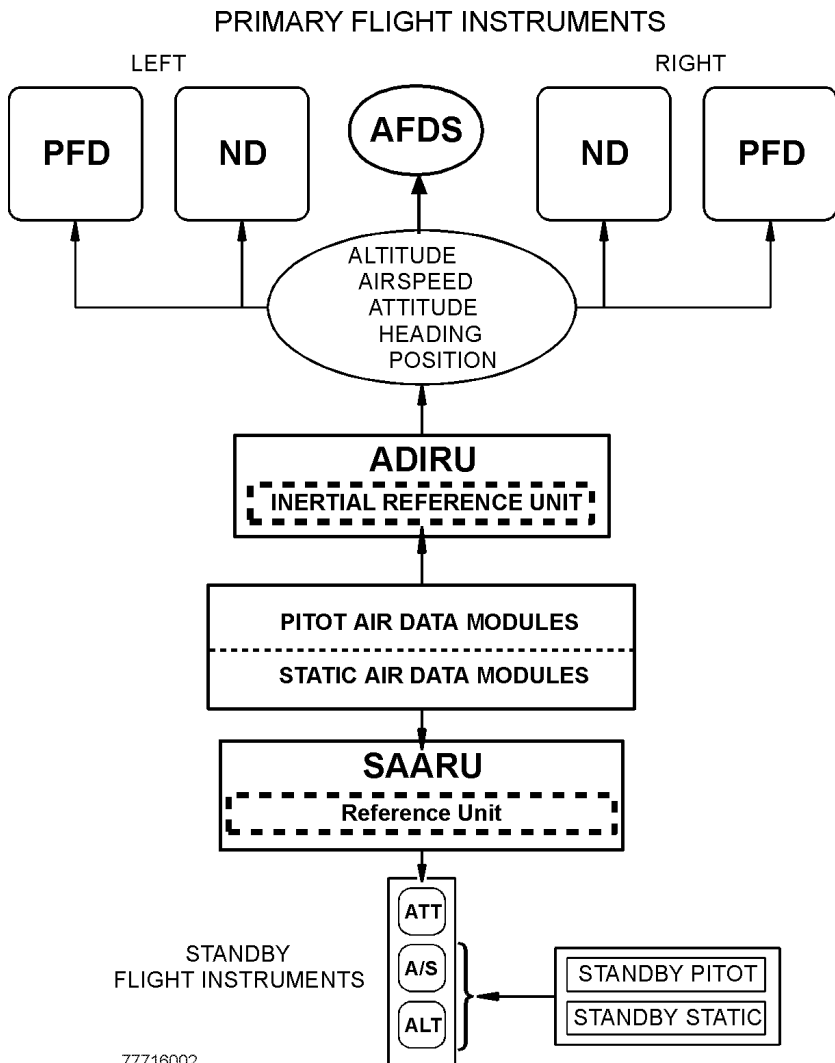
When ADIRU air data is invalid and the AIR DATA/ATT switch is in the OFF position, valid SAARU air data is used. Refer to Section 6.10, Flight Instruments, Displays for a description of the AIR DATA/ATT switch.

Single channel operation occurs when the ADIRU and SAARU air data are invalid. The left PFD shows the ADIRU air data from the left pitot static system (left channel). The right PFD shows the SAARU air data from the right pitot static system (right channel). The EICAS shows the message **NAV AIR DATA SYS**.

The air data modules are remote sensors for the air data functions within the ADIRU and SAARU. They measure static and pitot pressure. Both the ADIRU and SAARU receive data from all air data modules. In addition, the ADIRU and SAARU each receive data from the two angle of attack vanes and a dual element total air temperature probe.

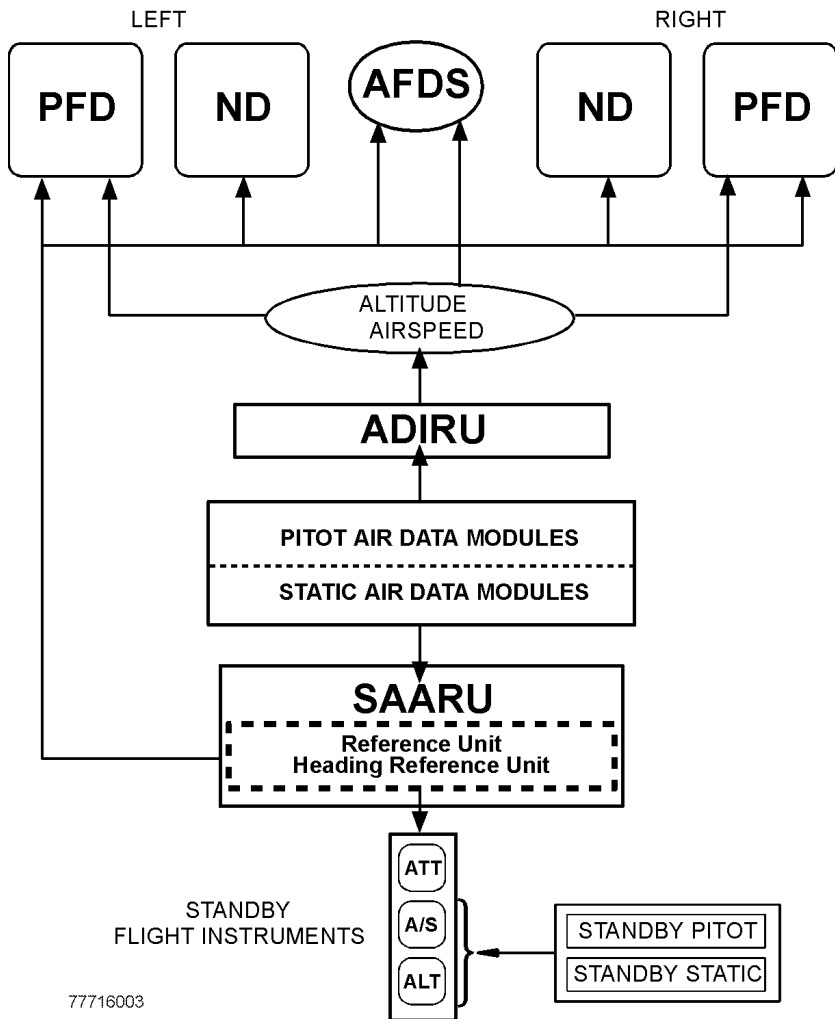
The standby flight instrument displays receive data from the center pitot and static ports through standby air data modules. Altitude and airspeed are independent of ADIRU and SAARU values.

ADIRS Schematic, Normal Mode



ADIRS Schematic, With NAV ADIRU INERTIAL Message

PRIMARY FLIGHT INSTRUMENTS



RADIO NAVIGATION SYSTEMS

Automatic Direction Finding (ADF)

Two ADF systems are installed. Either ADF can be manually tuned from the left or right CDU on the NAV RADIO page.

ADF Displays

Left and right ADF bearings are shown on the ND when the related VOR/ADF switch is in the ADF position. ADF data is cyan.

If both FMCs fail, the left and right ADF radios are tuned on the related left and right CDU ALTN NAV RADIO page.

Distance Measuring Equipment (DME)

Two DME systems are installed. The DMEs are usually tuned by the FMC, but may be tuned manually.

DME Tuning

DME is tuned manually when the VOR portion of a VOR/DME pair is entered on the NAV RADIO page. The FMC tunes DME as necessary for radio position updates. Manual DME tuning does not inhibit FMC DME tuning.

The FMC uses two DMEs for position updates. DME/DME position updates are usually more accurate than VOR/DME updates. The FMC cannot tune specific DMEs if the navaids are inhibited on the REF NAV DATA page.

After dual FMC failure, the left DME is tuned with the left CDU and the right DME is tuned with the right CDU. Each DME is tuned to the VOR shown on the CDU unless the related EFIS control panel ND mode selector is set to APP. In APP, the DME is tuned to the ILS.

DME Displays

DME distance is shown on the ND map display when operating in the VOR mode. DME distances are also shown when the ND mode selector is in the VOR or APP position, and either or both VOR L or VOR R switches are selected. DME distance is also shown on the PFD when the ILS receivers are tuned to a collocated DME and localizer facility.

POS REF page 2/3 shows the identifiers of the DME stations used for FMC position updates.

Instrument Landing System (ILS)

Three ILS receivers are installed. They are usually tuned by the FMC, but can be tuned manually on the NAV RADIO page.

ILS Tuning

Two conditions must be met for FMC ILS auto tuning to occur; they are:

- An ILS, LOC, back course approach or an ILS/LOC runway must be in the active route, and
- The airplane must be less than 50 NM from the top of descent, or less than 150 NM from the landing runway threshold, or the FMC is in descent mode.

On initial takeoff, ILS auto tuning is inhibited for 10 minutes to prevent clutter on the PFD. Selection and execution of a new approach in the active flight plan causes the ILS to auto tune to the new approach frequency, even if this is accomplished during the 10 minute takeoff inhibit period. ILS auto tune inhibit does not apply to subsequent takeoffs on the same flight (for example, touch-and-go or stop-and-go landings).

All three ILS receivers can be manually tuned from the NAV RADIO page at anytime unless ILS approach tuning inhibit is active.

ILS approach tuning inhibit is active when:

- The autopilot is engaged and either the localizer or glideslope is captured
- The flight director is engaged, and either the localizer or the glideslope is captured, and the airplane is below 500 feet radio altitude, or
- On the ground, the localizer is alive, airplane heading is within 45° of the localizer front course, and ground speed is greater than 40 knots.

Attempting to manually enter an ILS frequency or attempting to select and execute a different ILS approach when ILS approach tuning inhibit is active shows the CDU scratchpad message **ILS TUNE INHIBITED-MCP**.

ILS tuning is again enabled when:

- Either TOGA switch is pushed
- The autopilot is disengaged and both flight director switches are switched off, or
- The MCP approach mode is deselected above 1500 feet radio altitude.

The ILS frequency is automatically re-tuned when ILS tuning is enabled and a new approach is selected on the CDU.

After dual FMC failure, the left and center ILS receivers are tuned with the left CDU on the ALTN NAV RADIO page. The right ILS receiver is tuned with the right CDU on the ALTN NAV RADIO page.

ILS Displays

The tuned ILS frequency is shown on the PFD and on the ND in the approach mode.

Localizer and glideslope deviation are shown on the PFD. Localizer and glideslope deviation, and selected course is shown on the ND when that ND is in the approach mode. Front or back course deviation is determined from airplane heading.

Navaid Identifier Decoding

The Morse code identifier of a tuned VOR, ILS, DME, or ADF can be converted to alpha characters. The decoded identifier is then shown on the PFD and ND. The crew should monitor this identifier for correct navigation radio reception. The identifier name is not compared with the FMC database.

Due to the large variation in ground station identifier quality, the decode feature may incorrectly convert the intended identifier name. Examples: the Hong Kong localizer “KL” may show as “KAI”, or the Boeing Field ILS may show as “QBFI” or “TTTT” instead of “IBFI.”

Pilots should verify the identity of the tuned navigation station from the audio Morse code when the tuned frequency remains shown or an incorrect identifier is shown.

VOR

Two VOR receivers are usually tuned by the FMC but can be tuned manually by the crew. The tuned VORs are shown on the ND and may be used for position updates.

VOR Tuning

The crew manually tunes VORs on the NAV RADIO page.

The FMC can tune a VOR and a collocated DME for position updates. The FMC uses VOR/DME radio position updates when more accurate sources are not available. Specific VOR/DME pairs can be inhibited on the REF NAV DATA page. If the crew enters two VOR identifiers on the NAV RADIO page, then the FMC cannot tune any other station for VOR/DME updates.

After dual FMC failure, the VOR radios can be manually tuned on the CDU ALTN NAV RADIO page. The left VOR is tuned with the left CDU and the right VOR is tuned with the right CDU.

VOR Displays

The NAV RADIO page shows FMC tuned or manually tuned VOR data. POS REF page 2/3 shows the identifier of the VOR and DME pair used for position updates.

The ND shows the identifier or frequency of the VORs tuned on the NAV RADIO page. The FMC usually tunes the same VOR in the left and the right. The ND VOR L VOR R data are usually the same.

Left and right VOR bearings are shown on the ND map display when the related EFIS control panel VOR/ADF switch is in the VOR position. VOR bearings are also shown when the ND mode selector is in the VOR or APP position, and either or both VOR L or VOR R switches are selected. The VOR frequency and selected course are shown in the upper right hand corner of the ND when operating in the VOR mode. The ND also shows course deviation when operating in the VOR mode.

Transponder

The transponder panel controls two ATC transponders and the Traffic Alert And Collision Avoidance System (TCAS). Traffic is shown if the transponder mode selector is in TA ONLY or TA/RA. In flight, the selected transponder activates beacon and altitude reporting when the transponder mode selector is in XPNDR, TA ONLY, or TA/RA. The EICAS advisory message **TRANSPONDER L** or **TRANSPONDER R** is shown if the selected transponder fails. If altitude reporting fails, the transponder can be switched to the alternate altitude source. Refer to Section 6.15, Warning Systems, for a description of TCAS.

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FLIGHT MANAGEMENT SYSTEM DESCRIPTION

INTRODUCTION

The Flight Management System (FMS) aids the flight crew with navigation, in-flight performance optimization, automatic fuel monitoring, and flight deck displays. Automatic flight functions manage the airplane lateral flight path (LNAV) and vertical flight path (VNAV). The displays include a map for airplane orientation and command markers on the airspeed, altitude, and thrust indicators to help in flying efficient profiles.

The flight crew enters the applicable route and flight data into the CDUs. The FMS then uses the navigation database, airplane position, and supporting system data to calculate commands for manual and automatic flight path control.

The FMS tunes the navigation radios and sets courses. The FMS navigation database supplies the necessary data to fly routes, SIDs, STARs, holding patterns, and procedure turns. Cruise altitudes and crossing altitude restrictions are used to calculate VNAV commands. Lateral offsets from the programmed route can be calculated and commanded.

FLIGHT MANAGEMENT COMPUTER (FMC)

The basis of the flight management system is the flight management computer function. Since the term FMC is universally understood, it is used here for standardization and simplification.

Under normal conditions, one FMC accomplishes the flight management tasks while the other FMC monitors. The second FMC is ready to replace the first FMC if system faults occur.

The FMC uses flight crew-entered flight plan data, airplane systems data, and data from the FMC navigation database to calculate airplane present position and pitch, roll, and thrust commands necessary to fly an optimum flight profile. The FMC sends these commands to the autothrottle, autopilot, and flight director. Map and route data are sent to the NDs. The EFIS control panels select the necessary data for the ND. The mode control panel selects the autothrottle, autopilot, and flight director operating modes. Refer to the following sections for operation of these other systems:

- Section 6.4, Automatic Flight
- Section 6.10, Flight Instruments, Displays.

The FMC is certified for area navigation when used with navigation radio and/or GPS updating. The FMC and CDU are used for en route and terminal area navigation, RNAV approaches, and to supplement to primary navigation means when conducting other types of non-precision approaches.

Control Display Units (CDUs)

The flight crew controls the FMC using three CDU's. The CDU's give alternate display, communications control, and navigation capability if there is a dual FMC failure (refer to the Alternate Navigation section of this chapter). The center CDU is a backup for the left or right CDU in case of a failure and automatically takes over functionality of the failed CDU. Only the left and right CDUs tune navigation radios when alternate navigation is active.

Left and right CDUs provide backup to the left and right EFIS control panels, while the center CDU provides EFIS control panel backup for a failed left or right CDU. If the EFIS control panel or the display select panel fails, a manual selection of the CDU backup mode can be made on the MENU page.

Refer to Section 6.10, Flight Instruments, Displays for a description of alternate display control. Refer to Section 6.5, Communications, for a description of communications control.

FLIGHT MANAGEMENT SYSTEM OPERATION

INTRODUCTION

When first powered, the FMS is in the preflight phase. As a phase is completed, the FMS automatically changes to the next phase in this order:

- Preflight
- Takeoff
- Climb
- Cruise
- Descent
- Approach
- Flight complete.

FMS OPERATING PHASES

Preflight

During preflight, flight plan and load sheet data are entered into the CDU. This data is entered manually. Some data can be entered by data link. The flight plan defines the route of flight from the origin to the destination and initializes LNAV. Flight plan and load sheet data provide performance data to initialize VNAV.

Required preflight data consists of:

- Initial position
- Route of flight
- Performance data
- Takeoff data.

Optional preflight data includes:

- Navigation database selection
- Route 2
- Alternate airport
- SID
- STAR
- Thrust limits
- Wind.

Each required or optional data item is entered on specific preflight pages.

Preflight starts with the IDENT page. If the IDENT page is not shown, it can be selected with the **IDENT** prompt on the INIT/REF INDEX page. Visual prompts help the flight crew select necessary CDU preflight pages. Preflight pages can be manually selected in any order.

After the necessary data on each preflight page is entered and checked, push the lower right line select key to select the next preflight page. When **ACTIVATE** is selected on the ROUTE page, the execute (**EXEC**) light illuminates. Push the EXEC key to make the route active.

Use the departure/arrival (DEP/ARR) page to select a standard instrument departure (SID). Selection of the SID may cause a route discontinuity. The modification must be connected to the existing route and executed. This can be accomplished on the ROUTE or LEGS page.

When all required preflight entries are complete, the PRE-FLT label on the TAKEOFF REF page is no longer shown. The **THRUST LIM** prompt is shown at the next page line select key location.

Takeoff

The takeoff phase starts with selection of TO/GA and extends to the thrust reduction altitude where climb thrust is normally selected. LNAV and VNAV can be armed before takeoff to engage at the applicable time (refer to Section 6.4, Automatic Flight).

Climb

The climb phase starts at the thrust reduction altitude and extends to the top of climb (T/C) point. The T/C point is where the airplane reaches the cruise altitude entered on the PERF INIT page.

Cruise

The cruise phase starts at the T/C point and extends to the top of descent (T/D) point. Cruise can include step climbs and en route descents.

Descent

The descent phase starts at the T/D point or when either flight level change (FLCH) or vertical speed (V/S) is selected. The descent phase extends to the start of the approach phase.

Approach

The approach phase starts when the first waypoint of the procedure sequences or when the runway is the active waypoint and the distance to go is less than 25 NM.

Flight Complete

Thirty seconds after engine shutdown, the flight complete phase clears the active flight plan and load data. Some preflight data fields initialize to default values in preparation for the next flight.

Operational Notes

When operating in the LNAV and VNAV modes, system operation must be monitored for unwanted pitch, roll, or thrust commands. If unwanted operation is noticed, roll and pitch modes other than LNAV and VNAV must be selected.

The system must be carefully monitored for errors following:

- Activation of a new data base
- Power interruption
- ADIRU failure.

The FMC will not sequence the active waypoint when: more than 21 nm off the active route and not on an offset route. Return to the active route can be accomplished using the DIRECT TO or INTERCEPT COURSE TO/FROM procedures.

When a waypoint is in the route more than once, certain route modifications (such as DIRECT TO and HOLD) are based on the first waypoint in the route.

Some SIDs or STARS contain a heading vector leg. VECTORS waypoints show on the ND as a magenta line without an end point leading away from the airplane symbol. If LNAV is engaged, the DIRECT TO or INTERCEPT COURSE TO/FROM procedure can be used to start waypoint sequencing beyond the vectors leg.

When entering airways in a route page, the start and end waypoints must be in the database. A route segment must be entered as a DIRECT leg.

If the engines remain operating between flights, entering a new cruise altitude before the next flight recalculates the proper vertical profile.

If a climb to cruise altitude is necessary after completing a descent, a new cruise altitude entry must be made. Cruise altitude can be entered on the CLB page.

DIRECT TO courses are segments of a great circle route. When entering a DIRECT TO waypoint on the LEGS page, the course above the waypoint before execution is the arrival course at the waypoint. However, after execution, the course is the current course to fly to the waypoint. These courses may not be the same.

TERMINOLOGY

The following paragraphs describe FMC and CDU terminology.

Active - Flight plan data currently being used to calculate LNAV or VNAV guidance commands.

Activate - The procedure to change an inactive route to the active route for navigation. It is a two step procedure.

- Select the **ACTIVATE** prompt
- Push the execute (EXEC) key.

Altitude constraint - a crossing restriction at a waypoint.

Delete - Remove FMC data and revert to default values, dash or box prompts, or a blank entry using the DELETE key.

Econ - A speed schedule calculated to minimize operating cost. The economy speed is based on the cost index. A low cost index causes a lower cruise speed. Maximum range cruise or the minimum fuel speed schedule may be obtained by entering a cost index of zero. This speed schedule ignores the cost of time. A minimum time speed schedule may be obtained by entering a cost index of 9999. This speed schedule calls for maximum flight envelope speeds. A low cost index may be used when fuel costs are high compared to operating costs.

Enter - Put data in the CDU scratchpad and then line select the data to the applicable location. New characters can be typed or existing data can be line selected into the scratchpad.

Erase - Remove entered data, which has resulted in a modification, by selecting the **ERASE** prompt.

Execute - Push the EXEC key to make modified data active.

Inactive - Data used to calculate LNAV or VNAV commands after the activate procedure is complete. This could be climb, cruise, descent, performance, or route data.

Initialize - Entering data required to make the system operational.

Message - Data the FMC automatically writes in the scratchpad to tell the flight crew of a system condition.

Modify - Active data that is changed but not yet executed. When a modification is made to the active route or performance mode, **MOD** is shown in the page title, **ERASE** shows next to line select key 6 left, and the execute key illuminates.

Prompt - CDU displays that aide the flight crew in accomplishing a task. Prompts can be boxes, dashes, or a caret (< or >) line to remind the flight crew to enter or validate data.

Purge - Select the **PURGE** prompt to remove all airports uplinked to the ALTN LIST. (Not operational on CAL aircraft.)

Select - Pushing a key to obtain the necessary data or action, or to copy selected data to the scratchpad.

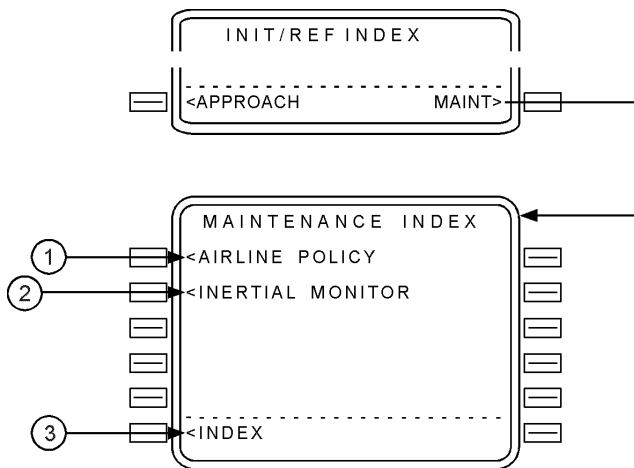
Speed restriction - An airspeed limit associated with a specified altitude entered by the flight crew.

Speed transition - An airspeed limit associated with a specified altitude automatically entered by the FMC.

Waypoint - A point on the route. It can be a fixed point; such as, a latitude and longitude, VOR or ADF station, airway intersection, or a conditional waypoint. A conditional waypoint is not associated with a land reference; it is based on a time or altitude requirement. An example of a conditional waypoint is “when reaching 4000 feet.”

Maintenance Index

The MAINTENANCE INDEX page prompts are normally used only on the ground.



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- ① Airline Policy
Shows the AIRLINE POLICY page.
- ② Inertial Monitor
This is a maintenance function.
- ③ Index
Push - Displays the INIT/REF INDEX page.

Airline Policy

The airline policy pages show operating parameters kept in the airline maintained file. The FMC references this file for data before it calculates default values. These pages are not usually used by the flight crew.

AIRLINE POLICY 1/2 page is shown when the **AIRLINE POLICY** prompt is selected from the MAINTENANCE INDEX page.

NAVIGATION POSITION

The FMC determines present position from these navigation systems: ADIRS, GPS, and navigation radios. When receiving reliable GPS data, the primary mode of navigation is from a GPS updated FMC position. If GPS data is not available, cannot be validated, or is inhibited, the FMC position is updated using navigation radios. When navigation radios are not available or not reliable, the FMC position comes from the ADIRU.

FMC Position Update

FMC position may be manually updated to any of the navigation system positions. This update is accomplished on POS REF page 2.

On the ground, the FMC calculates present position based on ADIRU and/or the GPS data.

With GPS NAV OFF, pushing a TO/GA switch updates the FMC position to the takeoff runway threshold or to the position shift position, when entered.

When making an intersection takeoff, the intersection displacement distance from the runway threshold must be entered on the TAKEOFF REF page.

With GPS NAV ON, the TO/GA update is inhibited.

In flight, the FMC position is continually updated from the GPS, navigation radios, and ADIRU. Updating priority is based on the availability of valid data from the supporting systems.

The FMC automatically tunes VOR, DME, and ILS radios for position updating. Selection is related to the active route and any procedure (SID, STAR, etc.) in the active route. Manually selecting VOR frequencies or identifiers precludes the FMC from autotuning other VOR frequencies for position updating; however, the FMC continues to tune DME-DME pairs for position updating.

FMC position updates from navigation sensor positions occurs in the following priority order:

- One LOC and GPS
- One LOC and collocated DME
- GPS
- Two DME stations
- One VOR with a collocated DME
- ADIRU.

The selected station identifiers of the radio navigation aids are shown on the POS REF page 2.

Primary FMC Position Update Source	POS REF page 2/3	ND Annunciation
LOC, GPS valid*	LOC-GPS	LOC-GPS
LOC, DME DME valid; GPS invalid*	LOC-RADIO	LOC-DME-DME
LOC, VOR DME valid; GPS invalid*	LOC-RADIO	LOC-VOR-DME
LOC valid; GPS, DME, VOR invalid*	LOC	LOC
DME valid; GPS invalid	RADIO	DME-DME
VOR DME valid; GPS invalid	RADIO	VOR-DME
GPS, VOR, DME invalid	INERTIAL	INERTIAL
GPS valid; ADIRU failed	GPS	GPS
GPS valid; LOC invalid	GPS	GPS
GPS invalid; ADIRU failed	blank	map not available
* The FMC changes to LOC updating when: <ul style="list-style-type: none"> • The tuned localizer is associated with the destination runway • The airplane heading is within 45° of the localizer course • The airplane is within 20 NM of the destination airport • The airplane is within 2.5° of the localizer center. 		

FMC Polar Operations

The FMC starts polar operations when the calculated airplane position enters a polar region. The FMC switches all flight display inputs to reference true north while in these regions. When available, GPS provides navigation data to the FMC throughout polar regions. If GPS information is lost, the ADIRU provides a single inertial navigation position to the FMC to ensure continuous navigation throughout polar regions.

Automatic switching to a true north reference is annunciate by a flashing white box around the word **TRU** on the ND. A TRUE heading reference can be selected with the heading reference switch inside or outside the polar region. The ND shows a green box around the word **MAG** to annunciate the change back to magnetic reference. If the heading reference is **TRU** in the descent phase, the ND shows an amber box around the word **TRU**.

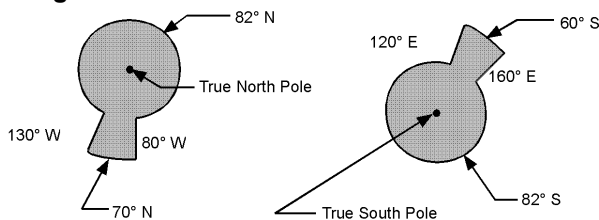
The current GRID heading displays near the top of both NDs when the airplane is north of 70°N or south of 70°S. The GRID heading is not used by any airplane system.

Note: When operating the autopilot in the polar region in other than LNAV, the **TRUE** position on the heading reference switch must be selected.

Note: When operating north of 82°N or south of 82°S using the ND PLAN mode, the airplane position symbol does not display.

Note: If the ADIRU fails in a polar region, the EICAS message **NAV ADIRU INERTIAL** displays and all autopilot and AFDS roll modes fail. When heading information is restored by entry of a reference heading on the POS INIT page, HDG SEL and HDG HOLD roll modes are restored. GPS continues to provide navigation data to the FMC and active route information displays on the ND. When operating in this degraded mode, heading on the POS INIT page may be referenced to magnetic, true, or grid heading. The heading display drifts significantly under these conditions. Periodic updating of the heading reference on the POS INIT page should be accomplished at least every 10 minutes.

FMC Polar Regions

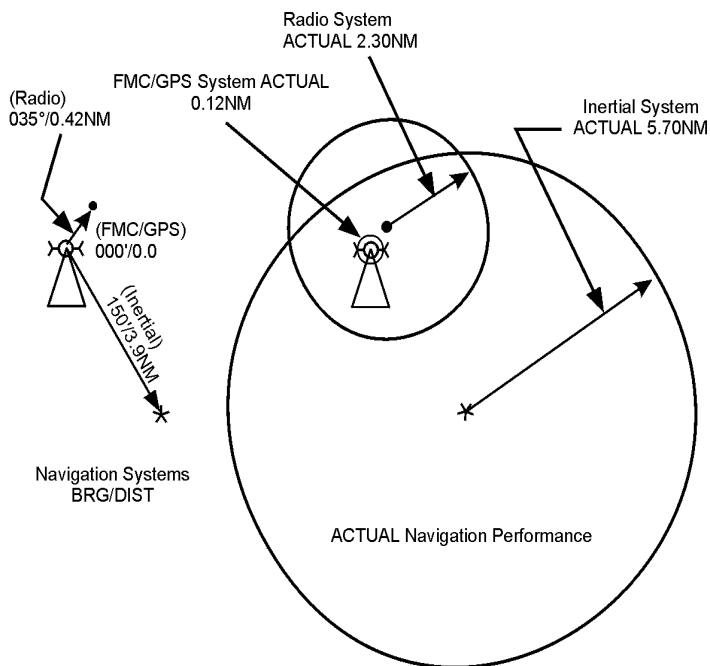


Navigation Performance

POS REF		2 / 3
FMC (GPS)		UPDATE
N47' 32.4 W122' 18.6	ARM>	
INERTIAL	ACTUAL	5.70
150' / 3.9NM		
GPS	ACTUAL	0.12
000' / 0.0NM		
RADIO	ACTUAL	2.30
035' / 0.42NM		
RNP / ACTUAL	DME DME	
4.00 / 0.12NM	PDX SEA	

< INDEX	LAT / LON >	

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The FMC uses data from the navigation systems to accurately calculate the position of the airplane. The current FMC position is shown on line 1 of the POS REF page 2. The primary source of update is shown in parentheses above the FMC position.

The navigation system positions are shown on the left side of lines 2 through 4. The bearing/distance is from the FMC position to the individual navigation system position.

The FMC position is shown on the ND at the tip of the triangle. All other positions are shown relative to the FMC. The RADIO position is shown above as a ●, but is not shown on the ND. The ACTUAL navigation performance circles shown above are not shown on the ND.

Actual Navigation Performance

Actual Navigation Performance (ANP) is the FMC current computed position accuracy. It is titled ACTUAL and displays on the POS REF page 2 for the navigation system displayed in title line 1. ACTUAL navigation performance is a circular prediction centered at the FMC position. Airplane position is estimated to be within this ACTUAL navigation performance circle 95 percent of the time.

After a manual position update, the ACTUAL navigation performance of the FMC changes to the ACTUAL navigation performance of the selected navigation system. In the example above, a manual position update to the INERTIAL system would change the FMC ACTUAL navigation performance to 5.7 NM. The FMC then updates from the best available navigation system and eventually, the manual update has no effect on position calculation. Some automatic updates can be inhibited; GPS on POS REF page 3 and VOR/DME updates on the REF NAV DATA page. Inertial and DME/DME updates can not be inhibited.

Required Navigation Performance

Required Navigation Performance (RNP) is the navigation accuracy required for operation within a defined airspace. It is expressed in nautical miles. RNP values have been published for areas of operation around the world. Operations in these areas require on-board navigation systems to alert the flight crew if ANP exceeds RNP. The FMC supplies a default RNP value for takeoff, en route, oceanic / remote, terminal, and approach phases of flight. The flight crew may enter an RNP value, if required. RNP displays on POS REF page 2.

Lateral Navigation (LNAV)

LNAV provides steering commands to the next waypoint or the selected route intercept point. When armed on takeoff, LNAV engages at or above 50 feet, when laterally within 2.5 nautical miles of the active route leg. FMC LNAV guidance normally provides great circle courses between waypoints.

However, when an arrival or approach from the FMC database is entered into the active route, the FMC can supply commands to fly a constant heading, track, or follow a DME arc, as required by the procedure.

Waypoints

Waypoint (navigation fix) identifiers are shown on the CDU and navigation display.

The CDU message **NOT IN DATABASE** is shown if a manually entered waypoint identifier is not kept in the database. The waypoint can still be entered as a latitude/longitude, place/bearing/distance or place/bearing/place/bearing waypoint.

FMC generated waypoints contain a maximum of five characters assigned according to the following rules.

Navaid Waypoint Names

VHF - Waypoints located at VHF nav aids (VOR/DME/LOC) are identified by the official one, two, three or four character facility identifier. Examples:

- Los Angeles VORTAC = LAX
- Tyndall TACAN = PAM
- Riga Engure, USSR = AN.

NDB - Waypoints located at NDBs are identified by use of the station identifier. Example: FORT NELSON, CAN - YE.

Fix Waypoint Names

Fixes with one-word names waypoints located at fixes with names containing five or fewer characters are identified by the name. Examples:

- DOT
- ACRA
- ALPHA.

Long Waypoint Names

Names with more than five characters are abbreviated using the following rules sequentially until five characters remain. Double letters are deleted.

Examples:

- KIMMEL becomes KIMEL
- COTTON becomes COTON
- RABBITT becomes RABIT.

Keep the first letter, first vowel and last letter. Delete other vowels starting from right to left. Examples:

- ADOLPH becomes ADLPH
- BAILEY becomes BAILY
- BURWELL becomes BURWL.

The next rule abbreviates names even further. Apply the previous rule, and then delete consonants from right to left. Examples:

- ANDREWS becomes ANDRWS then ANDRS
- BRIDGEPORT becomes BRIDGPRT then BRIDT
- HORSBA becomes HORS.

Fixes with multiword names use the first letter of the first word and abbreviate the last word, using the above rules sequentially until a total of five characters remain. Examples:

- CLEAR LAKE becomes CLAKE
- ROUGH ROAD becomes RROAD.

Unnamed Point Waypoint Names

Unnamed turn points, intersections and DME fixes - If an unnamed turn point, intersection or fix is collocated with a named waypoint or navaid on a different route structure (such as low altitude routes or an approach), the name or identifier of the collocated waypoint is used. Example:

- Unnamed turn point on J2 between the Lake Charles (LCH) and New Orleans (MSY) VORTACs is coincidental with the Lafayette (LFT) low altitude VORTAC. LFT is used as the identifier for the turn point.

Identifier codes for unnamed turn points not coincidental with named waypoints are constructed from the identifier of a navaid serving the point and the distance from the navaid to the point. If the distance is 99 nautical miles or less, the navaid identifier is placed first, followed by the distance. If the distance is 100 nautical miles or more, the last two digits are used and placed ahead of the navaid identifier. Examples (NAVAID / DISTANCE / IDENT):

- INW - 18 - INW18
- CSN - 106 - 06CSN

Unnamed Flight Information Region (FIR), Upper Flight Information Region (UIR), and controlled airspace reporting points - Waypoints located at unnamed FIR, UIR, and controlled airspace reporting points are identified by the three letter airspace type identification followed by a two digit sequence number. Example:

- FRA01

Unnamed oceanic control area reporting points in the northern hemisphere use the letters N and E, while points in the southern hemisphere use the letters S and W. Latitude always precedes longitude. For longitude, only the last two digits of the three-digit value are used.

Placement of the designator in the five-character set indicates whether the first longitude digit is 0 or 1. The letter is the last character if the longitude is less than 100° and is the third character if the longitude is 100° or greater.

N is used for north latitude, west longitude. E is used for north latitude, east longitude. S is used for south latitude, east longitude. W is used for south latitude, west longitude. Examples:

- | | |
|----------------------------|-----------------------------|
| • N50° W040° becomes 5040N | • S52° W075° becomes 5275W |
| • N75° W170° becomes 75N70 | • S07° W120° becomes 07W20 |
| • N50° E020° becomes 5020E | • S50° E020° becomes 5020S |
| • N06° E110° becomes 06E10 | • S06° E110° becomes 06S10. |

Procedure Arc Fix Waypoint Names

Unnamed terminal area fixes along a DME arc procedure - Unnamed fixes along a DME arc procedure are identified with the first character D. Characters 2 through 4 indicate the radial on which the fix lies. The last character indicates the arc radius. The radius is expressed by a letter of the alphabet where A = 1 mile, B = 2 miles, C = 3 miles and so forth. Examples:

- EPH252°/24 = D252X
- EPH145°/24 = D145X
- GEG006°/20 = D006T.

An unnamed waypoint along a DME arc with a radius greater than 26 miles is identified as an unnamed turn point that is not coincidental with a named waypoint. Examples:

- CPR338°/29 = CPR29
- GEG079°/30 = GEG30.

When there are multiple unnamed waypoints along a DME arc with a radius greater than 26 miles, the station identifier is reduced to two characters, followed by the radius, and then a sequence character. Examples:

- CPR134°/29 = CP29A
- CPR190°/29 = CP29B
- CPR201°/29 = CP29C.

DME step down fixes are identified by the distance and a “D.” Examples: 138D, 106D, 56D, 3D.

Procedure Fix Waypoint Names

Marker beacons -a marker beacon is identified by the marker type identifier followed by the runway number. Examples:

- Outer Marker 13R = OM13R
- Middle Marker 21 = MM21.

Runway – related - fixes - waypoints located at unnamed runway related fixes are identified by adding a two-letter prefix to the runway number. The following list is used to determine the applicable prefix:

- RX - Runway Extension Fix
- FA - VFR Final Approach Fix
- CF - Final Approach Course Fix
- FF - Final Approach Fix
- IF - Initial Approach Fix
- OM - Outer Marker
- MM - Middle Marker
- IM - Inner Marker
- BM - Back Course Marker
- MD - Minimum Descent Altitude
- A - (+ An Alpha) Step Down Fix
- RW - Runway Threshold
- MA - Missed Approach point other than RW
- TD - Touchdown Point Inboard of RW.

Examples: OM25L, MM09, IM23, RW04, RW18L.

For airports with more than one approach to the same runway, the two-letter prefix may change to allow different identifiers for the same waypoint. The first letter identifies the type of fix and the second letter identifies the type approach as follows:

- C() - Final approach course fix
- F() - Final approach fix
- P() - Missed approach point
- I() - Initial approach fix
- D() - Minimum descent altitude
- T() - Touch down point
- R() - Runway centerline intercept.
- ()I - ILS
- ()L - Localizer only
- ()B - Backcourse ILS
- ()D - VOR/DME
- ()V - VOR only
- ()S - VOR with DME points
- ()N - NDB
- ()Q - NDB with DME points
- ()M - MLS
- ()T - Tacan
- ()R - RNAV

Examples: CI32R, PV15, FN24L.

Unnamed turn points - Unnamed turn points that are part of a procedure are identified as a latitude and longitude waypoint. These include waypoints (except conditional waypoints) defined by flying a course or track from a waypoint (except conditional waypoints) to a radial or DME distance. These waypoints are automatically entered in a route by selection of a procedure using these waypoints, from the departures or arrivals page.

Airport reference points - Airport reference points are identified by the ICAO identifier.

Duplicate Waypoint Names

Duplicate identifiers - Application of the abbreviation rules creates identical identifiers for different waypoints. When a duplicate waypoint identifier is entered, the page changes to the SELECT DESIRED WPT page. The page lists the latitude and longitude of waypoints with the same identifier and the type of facility or waypoint. Select the latitude/longitude of the correct waypoint to enter the correct waypoint on the original page.

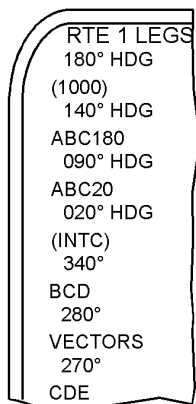
Conditional Waypoint Names

Conditional waypoints may be automatically entered into the route if a DEPARTURES or ARRIVALS page procedure is selected. Conditional waypoints cannot be manually entered on a ROUTE or LEGS page. These waypoints are events when a condition occurs and are not at a geographically fixed position. The types of conditions are:

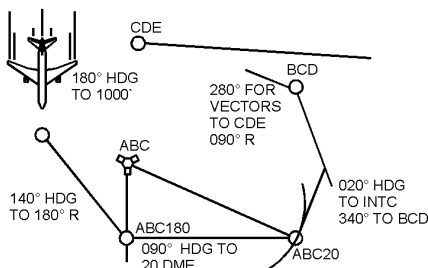
- Climb/descent through an altitude
- Intercepting a course
- Flying a heading to a radial or DME distance
- Heading vectors to a course or fix.

Altitude and course intercept conditional waypoints are shown on the CDU inside (parenthesis) marks. The diagram below shows conditional waypoints.

EXAMPLE:



MEANING:



Note: All waypoints except BCD and CDE are examples of conditional waypoints.

77716008

Manually Entered Latitude/ Longitude Waypoint Names

Pilot defined waypoints entered as a latitude and longitude are shown in a seven-character format. Latitude and longitude waypoints are entered with no space or slash between the latitude and longitude entries. Leading zeroes must be entered. All digits and decimal points (to 1/10 minute) must be entered unless the latitude or longitude are full degrees. Examples:

- N47° W008° is entered as N47W008 and shown as N47W008
- N47° 15.4' W0080 3.4' is entered as N4715.4W00803.4 and shown as N47W008.

Manually Entered Place-Bearing/Distance or Place-Bearing / Place-Bearing Waypoint Names

Waypoints entered as a place-bearing/distance or place-bearing/place-bearing are identified by the first three characters of the entry followed by a two-digit sequence number. Examples:

- SEA330/10 becomes SEA01
- SEA330/OLM020 becomes SEA02.

The two digit sequence numbers reserved for RTE1 are 01 through 49. The two digit sequence numbers reserved for RTE2 are 51 through 99.

Manually Entered Airway Crossing Waypoint Names

Airway crossing fixes are entered as a five-character waypoint name or by entering consecutive airways on the ROUTE page. In the latter case, the display is an X followed by the second airway name. Example: Entering J70 on the VIA line of the ROUTE page causes box prompts to show opposite on the same line. Leaving the box prompts empty and entering J52 on the next VIA line, directly below J70, causes the FMC to calculate the intersection of the two airways and replace the boxes with the waypoint identifier, XJ52.

Manually Entered Reporting Point Waypoint Names

Latitude or longitude reporting waypoints are entered as the full latitude or longitude followed by a slash, then the increment chosen for the following multiple waypoints. Example:

- W060/10 adds waypoints starting at W060 in ten degree increments from that point to the destination
- The entry must be made on a LEGS page on any line before the first reporting point
- Usually, this entry is made on the active waypoint line and proper sequencing is performed by the FMC.

Manually Entered Along Track Waypoint Names

Along track waypoints are a special case of place/bearing/distance waypoints applied to the current route. They do not cause route discontinuities when they are created.

Along track waypoints are entered using the waypoint name (the place), followed by a slash and minus sign, for points before the waypoint, or no sign for points after the waypoint, followed by the mileage offset for the newly defined waypoint. The route course takes the place of the bearing, which is not entered. The created waypoint is then inserted over the original waypoint. The distance offset must be less than the distance between the originating waypoint and next (positive value) or preceding (negative value) waypoint. Latitude and longitude waypoints cannot be used to create along track waypoints. Examples:

- VAMPS/25 is 25 miles after VAMPS on the present route, and is shown as VAM01
- ELN/-30 is 30 miles before ELN on the present route, and is shown as ELN01.

ND Map Displays

The route is shown on the ND in the map, map center, and plan modes. The display color and format represent the following status:

- An inactive route is shown as a cyan dashed line
- An activated, but not yet executed route, is shown as an alternating cyan/white dashed line
- The active route is shown in magenta
- Modifications to an active route are shown as dashed white lines
- Modified waypoints are shown in white
- Executed route offsets are shown as a dashed magenta line.

The ND shows the **FMC** position at the apex of the airplane symbol. All ND map data is shown relative to this apex.

When adequate GPS or radio updating is not available, the ND map may display a shift error. This error results in the displayed position of the airplane, route, waypoints, and navigation aids being shifted from their actual position. An undetected, across track map shift may result in the airplane flying a ground track that is offset from the desired track. An undetected, along track map shift may result in the flight crew initiating altitude changes earlier or later than desired. In either case, an undetected map shift may compromise terrain or traffic separation.

Map shift errors can be detected by comparing the position of the airplane on the ND map with data from the ILS, VOR, DME and ADF systems.

VERTICAL NAVIGATION (VNAV)

VNAV provides vertical profile guidance through the climb, cruise, and descent phases of flight.

Speed/Altitude Constraints

VNAV controls the path and speed to comply with waypoint crossing constraints. Waypoint crossing constraints are entered on the LEGS page waypoint line by pushing the applicable key on the right side of the CDU. Barometric altitude constraints must be below the cruise altitude to be valid. Values entered as part of a procedure and manually entered constraints are shown in large font. FMC predicted values do not act as constraints, and are shown in small font.

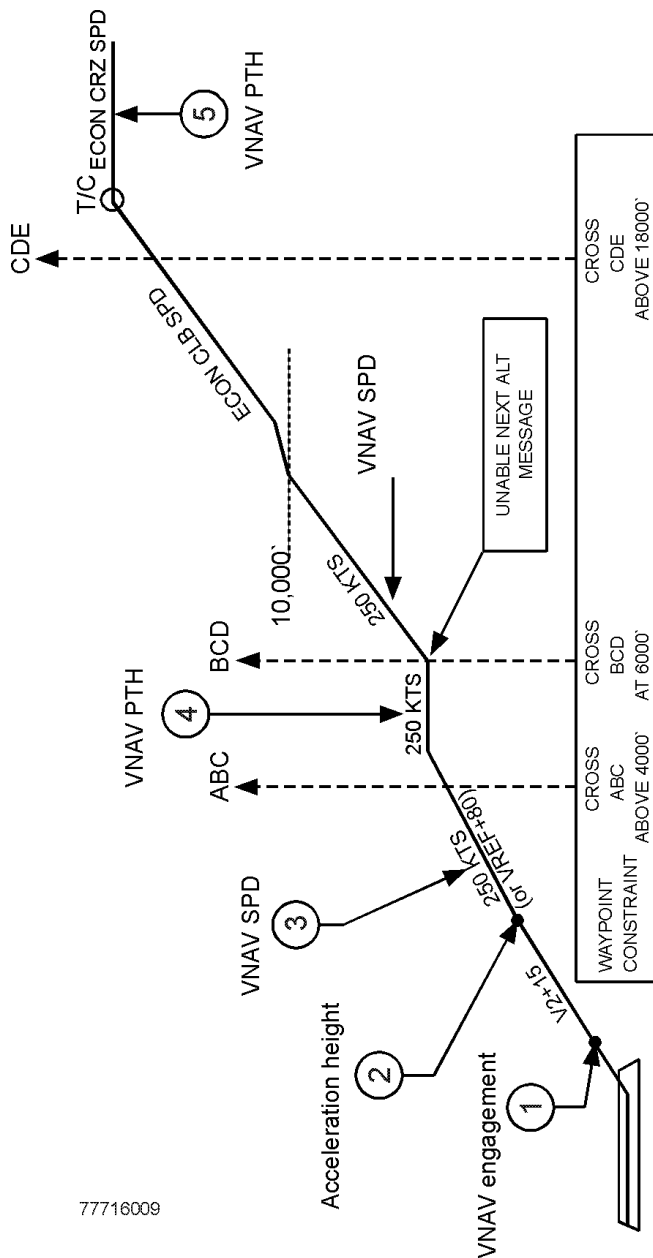
A waypoint constraint is magenta when it is active. The constraint does not have to be in line 1 to be active. Waypoints can have altitude or airspeed/altitude constraints.

Modified waypoint constraints are shaded white until they are executed. Speed constraint entries require an altitude constraint at the same waypoint. All speed constraints are considered by the FMC as at or below constraints.

At or above altitude constraints are entered with a suffix letter A (Example: 220A). At or below altitude constraints are entered with a suffix letter B (Example: 240B). Mandatory altitude constraints are entered without any suffix letter (Example: 270).

Altitude constraints with two altitudes may be entered in either order. The lower altitude constraint, followed by a suffix letter A, and the upper altitude constraint, followed by a suffix letter B (Example: 220A240B or 240B220A).

Takeoff and Climb



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① Takeoff

If armed for takeoff, VNAV engages at 400 feet and pitch guidance continues to maintain the target airspeed until the thrust reference mode changes.

During takeoff, the FMC updates the target airspeed to the current airspeed until VNAV activates. The target airspeed is between $V_2 + 15$ and $V_2 + 25$ knots.

② Acceleration Height

At the acceleration height, flap retraction, or AFDS altitude capture before acceleration height, VNAV commands an airspeed increase to the greater of 250 knots, $V_{REF} + 80$ knots, or the speed transition associated with the origin airport, limited by configuration.

The FMC changes the thrust reference mode to the selected climb thrust at the thrust reduction point.

③ VNAV Climb

The VNAV climb profile uses VNAV SPD or VNAV PTH at the default climb speed or pilot selected climb speed to remain within all airspeed and altitude constraints that are part of the SID entered into the active route. Autothrottle uses selected climb thrust limit.

If the climb speed profile cannot achieve an altitude constraint, the **UNABLE NEXT ALT** scratchpad message is shown.

④ Climb Constraints

VNAV enters the VNAV PTH mode to remain within departure or waypoint constraints. Speed maintained during this time can be:

- Procedure based speed restriction
- Waypoint speed restriction
- Default VNAV climb speed
- Manually entered climb speed.

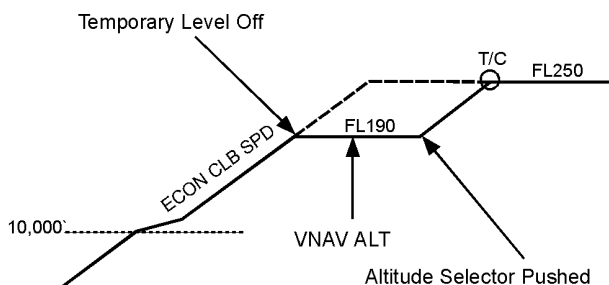
If the FMC predicts the aircraft will not reach an altitude constraint, the FMS-CDU message **UNABLE NEXT ALTITUDE** displays. Speed intervention can be used by pushing the IAS/MACH selector and manually setting a lower airspeed to provide a steeper climb; or, climb derates can be deleted on the THRUST LIMIT page.

⑤ Top Of Climb (T/C)

The point where the climb phase meets the cruise altitude is called the Top Of Climb. Approaching this point, the FMC changes from the climb phase to the cruise phase. The T/C is shown any time the FMC calculates a change from a climb phase to a cruise phase, such as a step climb.

The T/C point is shown on the map as a green open circle with the label T/C.

MCP Altitude Intervention



Whenever the airplane levels off at a MCP altitude that is not in the FMC, VNAV ALT engages. For example, FMC cruise altitude is FL250 and the clearance altitude, FL190, is set in the MCP. Pitch maintains altitude and thrust maintains FMC target speed. In the example, the speed after the temporary level off would be ECON CLB SPEED.

To resume the climb, put the clearance altitude into the MCP altitude window and push the altitude selector. VNAV SPD engages. Pitch maintains FMC speed and thrust increases to the climb limit. In the example, the airplane climbs to FMC CRZ ALT and then levels at FL250 in cruise.

Cruise

During cruise, the FMC commands economy cruise speed or the pilot entered speed until reaching the top-of-descent (T/D) point. Other cruise speed options are:

- Long range (LRC)
- Engine out (ENG OUT)
- Flight crew entered speed
- Flight crew entered constant Mach between two or more waypoints
- Required time of arrival (RTA).

The FMC uses maximum range cruise speed if cost index is set to zero. Cost index modifications are allowed until within ten miles of the top of descent.

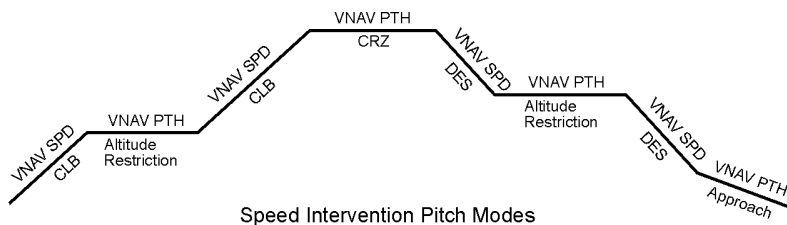
Step Climb

Fuel and ETA predictions assume the airplane climbs at each predicted step climb point as airplane weight decreases. FMC predicted step climb increments are based on the step size shown on the CRZ page. If a step size of zero is entered, the FMC assumes a constant altitude cruise.

Flight crew entry of a planned step altitude on the CRZ or RTE LEGS page overrides the FMC step climb predictions before that point. Entry of a planned step altitude on the RTE LEGS page overrides a "Step To" entry made on the CRZ page.

Predicted step altitudes are shown on the RTE LEGS page. The distance and ETA to the next step point (predicted or flight crew entered) are shown on the CRZ and PROGRESS pages. They are also shown on the ND map display with a green circle and S/C label.

Mode Control Panel Speed Intervention



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With VNAV engaged, pushing the IAS MACH selector enables speed intervention. Speed intervention allows the flight crew to change airplane speed with the IAS/MACH selector.

The above illustration shows the VNAV pitch flight mode annunciation for each phase of flight when using speed intervention.

In a VNAV descent after the T/D, VNAV PTH changes to VNAV SPD during speed intervention. In all other phases, the pitch mode does not change with speed intervention. Pitch controls speed in VNAV SPD mode, and during the VNAV PTH descent prior to speed intervention. Otherwise, thrust controls speed in VNAV PTH mode.

During a VNAV, non-precision approach while using speed intervention, the pitch mode is VNAV PTH. The vertical path is maintained regardless of IAS MACH selector changes.

VNAV changes to approach phase when:

- passing the first waypoint of an FMS approach (ILS, VOR, ect.), or
- the landing runway is the active waypoint and the direct distance to the runway is 25 NM or less.

If a “direct to” is executed to a waypoint in the approach, VNAV transitions to the approach phase when the airplane passes the “direct to” waypoint. If a waypoint located after the first waypoint of an FMC database approach is added and executed, VNAV will not transition to approach phase when passing the first waypoint of the approach.

Descent

The FMC calculates a descent path based on airspeed and altitude constraints and the end of descent (E/D) point. Dashed display on the LEGS page for speed and altitude descent waypoints. When an arrival or approach procedure is selected on the ARRIVALS page and incorporated into the flight plan, the FMC creates an E/D. The E/D is located 50 feet above the runway threshold (RW waypoint) for all approaches except VOR approaches. The E/D for VOR approaches is the missed approach point, which may be the VOR, runway waypoint (RWXXX), or a named waypoint. During cruise, an E/D is also created when an altitude constraint is entered on the LEGS page on a downstream waypoint.

The top of descent (T/D) is the point where the cruise phase changes to the descent phase. It displays on the ND as a green circle with the label **T/D**. The descent path starts at the T/D and includes waypoint altitude constraints. The path to the first constraint is based on:

- Idle thrust
- Wind entries on the DESCENT FORECAST page
- Speedbrakes retracted
- Predicted use of anti-ice
- FMC cruise wind
- Applicable target speed.

The descent may be planned at economy Mach/CAS (based on Cost Index) or a manually entered Mach/CAS. VNAV will not command an economy target speed greater than 314 knots (VMO/MMO minus 16 knots) or a pilot entered speed greater than 319 knots (VMO/MMO minus 11 knots).

The FMC creates the descent path with a deceleration at the speed transition altitude (typically 250 knots below 10,000 feet). VNAV plans a speed target 10 knots below the transition speed to allow for unknown tailwinds.

Descent path segments after the first altitude constraint waypoint are constructed as straight line point-to-point segments. The autothrottle provides thrust as required to maintain the path.

If flight plan modifications or unknown winds occur when above the first speed constraint, VNAV varies speed to maintain the path up to the following limits:

- With greater than 15 knots below the target speed, the autothrottle changes from IDLE/HOLD to SPD to provide thrust to accelerate to the target speed. If the autothrottle is not active, the scratchpad message **THRUST REQUIRED** displays. The airspeed may decrease to minimum maneuvering speed. Subsequently, VNAV commands the airplane to fly below the path to stop the deceleration. If VNAV can no longer maintain the airplane within 150 feet of the path without further deceleration, speed reversion occurs, the pitch mode annunciation changes from **VNAV PTH** to **VNAV SPD**, VNAV resets the target speed to 5 knots above the greater of best holding speed or minimum maneuvering speed, and the scratchpad message **THRUST REQUIRED** displays again.
- With greater than 314 knots (VMO/MMO minus 16 knots), the scratchpad message **DRAG REQUIRED** displays. The airplane may accelerate up to 319 knots (VMO/MMO minus 11 knots) to maintain the path. If further correction is required, VNAV may allow the airplane to rise up to 150 feet above the path. If VNAV can no longer maintain the airplane within 150 feet of the path without further acceleration, speed reversion occurs, the pitch mode annunciation changes from **VNAV PTH** to **VNAV SPD**, VNAV resets the target speed to 314 knots (VMO/MMO minus 16 knots), and the scratchpad message **DRAG REQUIRED** displays again.

If flight plan modifications or unknown winds occur when below the first speed constraint, VNAV varies speed to maintain the path up to the following limits:

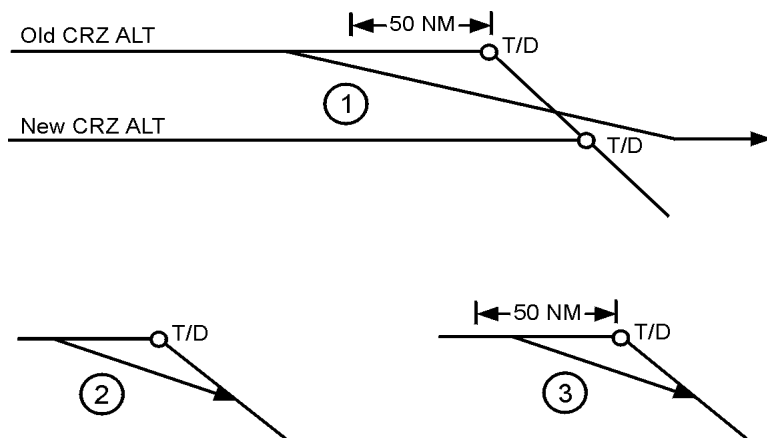
- With greater than 10 knots below the target speed, the autothrottle changes from IDLE/HOLD to SPD to provide thrust to accelerate to the target speed. If the autothrottle is not active, the scratchpad message **THRUST REQUIRED** displays. The airspeed may decrease to minimum maneuvering speed. Subsequently, VNAV commands the airplane to fly below the path to stop the deceleration. If VNAV can no longer maintain the airplane within 150 feet of the path without further deceleration, speed reversion occurs, the pitch mode annunciation changes from **VNAV PTH** to **VNAV SPD**, VNAV resets the target speed to 10 knots less than the target speed (not less than minimum maneuvering speed), and the scratchpad message **THRUST REQUIRED** displays again.

- With greater than 10 knots above target speed, the scratchpad message **DRAG REQUIRED** displays. The airplane may accelerate up to 15 knots above target speed to maintain the path. The maximum speed excursion allowed is 5 knots above the transition speed after the airplane is below transition altitude for the destination airport or 5 knots below the flaps placard speed if flaps are extended. If further correction is required, VNAV may allow the airplane to rise up to 150 feet above the path to stop the acceleration. If VNAV can no longer maintain the airplane within 150 feet of the path without further acceleration, speed reversion occurs, the pitch mode annunciation changes from **VNAV PTH** to **VNAV SPD**, VNAV resets the target speed to 250 knots, and the scratchpad message **DRAG REQUIRED** displays again.

Early Descents

An early descent in VNAV is any descent initiated prior to reaching the top of descent point (T/D). VNAV commands the descent at a reduced descent rate until the idle descent path is intercepted.

There are two types of early descents, a “Cruise Descent” and a “Descend Now.” In either early descent, the autothrottle mode annunciation is initially THR, followed by HOLD, allowing the pilot to adjust the rate of descent. The pitch mode is VNAV SPD.



① Cruise Descent

Use the MCP altitude selector to start a cruise descent. If the distance from T/D is more than 50 NM the FMC creates a new cruise altitude, with an associated new T/D, and VNAV begins a descent to the new cruise altitude. The pitch mode annunciation is **VNAV SPD** during descent and **VNAV PTH** at the new cruise altitude.

Depending upon proximity to T/D, VNAV may not capture the idle descent path since the target airspeed is economy cruise and the descent path is based on idle thrust and economy descent airspeed. In example

① VNAV levels at the new cruise altitude beyond the T/D, and the pitch mode annunciation is **VNAV ALT**.

② Descend Now

Use the **DES NOW** prompt on the VNAV DES page to start a Descend Now. The original path and T/D are not changed, and VNAV starts a descent (VNAV SPD) and captures the MCP altitude (VNAV ALT) or the idle descent path (VNAV PTH), whichever is encountered first.

The **DES NOW** function is also initiated whenever the MCP altitude selector is used to initiate a descent within 50 NM of the T/D (Example ③).

Approach

The FMC transitions to “on approach” under the following conditions:

- The aircraft is in the descent phase and flaps are out of UP, or
- A VFR approach is created and,
 - The aircraft has sequenced the FAXXX, or
 - The aircraft is enroute to a direct-to or intercept-to the RWYYY waypoint and the aircraft is within 25 NM of the runway threshold, or
 - The aircraft is enroute to a direct-to or intercept-to waypoint (**DIRECT** displays at 1L on RTE Page) in the descent profile and the aircraft is within 25 NM of the destination airport.
- A published instrument approach has been selected and incorporated in the active flight plan and,
 - The aircraft has sequenced the first waypoint on the published approach, or
 - The aircraft is enroute to a direct-to or intercept-to waypoint (**DIRECT** displays at 1L on RTE page) and the aircraft is within 12 NM of the runway threshold, or
 - The aircraft is enroute to a direct-to or intercept-to waypoint (**DIRECT** displays at 1L on RTE page) that is the last waypoint in the approach (runway or missed approach point) and the aircraft is within 25 NM of the destination airport.

The FMC transitions out of “on approach” under the following conditions:

- The pilot selects TOGA.
- The aircraft lands.
- The aircraft flies beyond the last waypoint in the approach (missed approach waypoint or runway) and the VNAV page title changes from “ACT xxxxx DES” to “ACT END OF DES.”

When the FMC is “on approach,” the following features are available:

- The IAS/MACH window can be opened and the command speed can be set while VNAV remains in **VNAV PTH** descent; VNAV commands the set speed.
- The MCP altitude can be set above the airplane altitude for the missed approach. When the MCP altitude setting is at least 300 feet above the current airplane altitude, VNAV continues to command a descent.
- VNAV remains in **VNAV PTH** and follows the descent path unless the airplane accelerates to within 5 knots of the current flap placard and the airplane rises more than 150 feet above the path. In this case, **VNAV PTH** changes to **VNAV SPD**.
- If an approach angle is specified for one or more legs on the approach, the angle displays on the LEGS page and VNAV provides **VNAV PTH** guidance at the displayed angle. When sequencing a waypoint prior to a descent leg specified by a descent angle, VNAV commands level flight until the aircraft intercepts the descent angle path.

Note: Display of a specified flight path angle is not limited to approaches. A flight path angle may be defined for a leg in a STAR and displays on the LEGS page for the procedure.

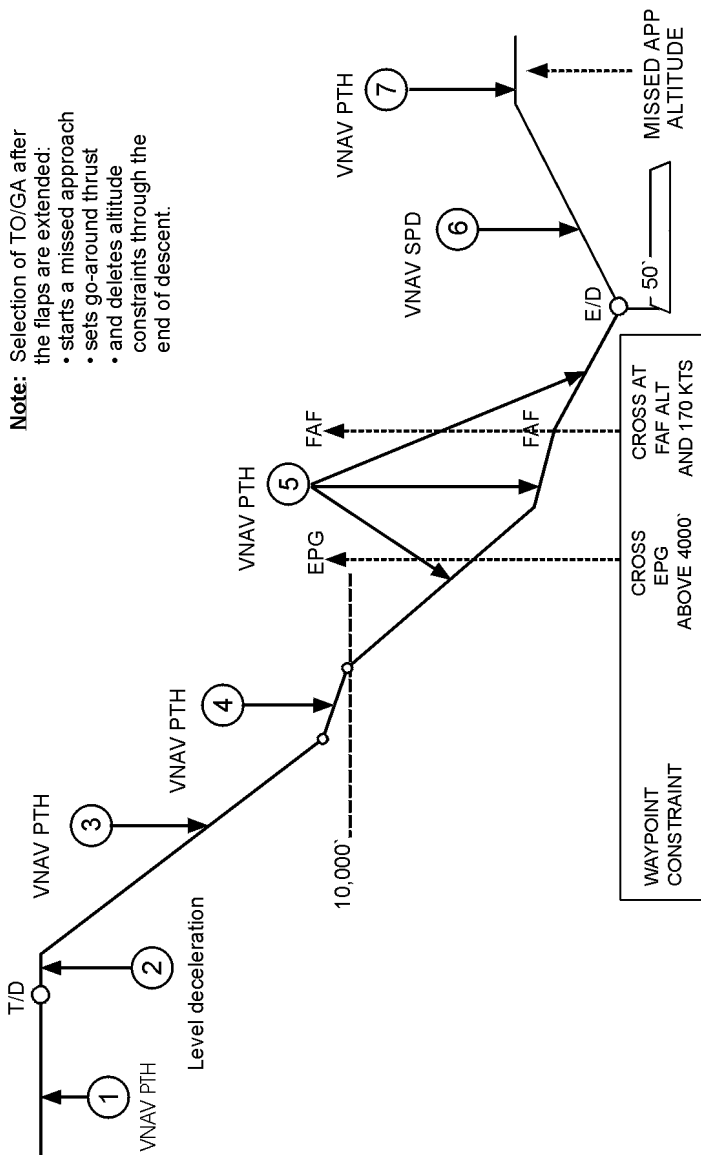
A side step to another approach can be accomplished by selection of the new approach on the ARRIVALS page. An along-course intercept to the next logical approach waypoint in the new approach can be selected on the INTC CRS TO line on the LEGS page or by selecting the **xxxxx INTC>** prompt on the ARRIVALS page.

Missed Approach

A missed approach is accomplished by selection of either TOGA switch. The following features are available:

- VNAV (and LNAV) can only be activated when the airplane climbs above 400 feet radio altitude.
- All descent altitude constraints below the current airplane altitude are deleted; the waypoints are retained in the active flight plan.
- The highest altitude in the missed approach procedure becomes the new cruise altitude.
- The FMC transitions from active descent to active climb. This transition also occurs when the aircraft climbs toward the MCP altitude and flaps are retracted from a landing position (25 or 30 towards 20, or 20 towards 5). For example, when a missed approach is accomplished without pushing the TOGA switch.
- AFDS guidance to fly the published missed approach procedure to the new cruise altitude is active when VNAV (and LNAV) are selected.
- When cruise phase is active, the speed target is the most restrictive of 250 knots (below speed transition altitude), best hold speed, or ECON cruise (above speed transition altitude).

Cruise and Descent Profile (Non-Precision Approach)



① Cruise

Before the top of descent, FMC is in cruise mode and uses VNAV PTH and ECON cruise speed.

② Level Deceleration Phase

At top of descent, FMC transitions to descent and commands the airspeed to ECON descent speed and maintains altitude in VNAV PTH.

③ Descent

Upon reaching descent speed, VNAV descends in VNAV PTH at ECON descent speed.

④ Descent Deceleration Phase

Before the speed restriction altitude, the FMC commands the target descent airspeed. The pitch mode remains VNAV PTH and the descent rate approximates 500 feet per minute.

⑤ Descent and Approach

When at target speed, VNAV commands a descent and starts approach in VNAV PTH at commanded speed.

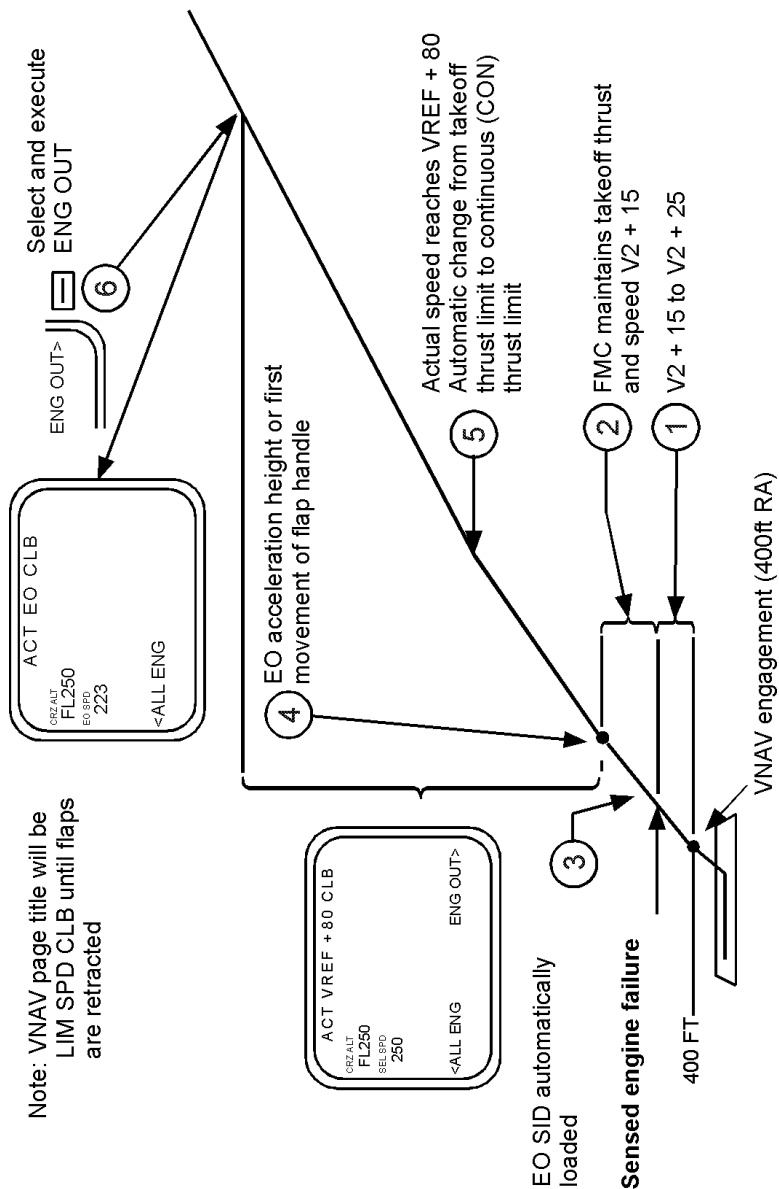
⑥ Missed Approach

When selected during missed approach, VNAV engages in VNAV SPD.

⑦ Missed Approach Level Off

At missed approach altitude VNAV SPD changes to VNAV PTH.

Takeoff and Climb (Engine Out)



① Takeoff

Condition: Before a sensed engine failure and above VNAV engagement altitude.

Result: **VNAV SPD** commands a climb at V_2+15 to V_2+25 knots. Autothrottle mode is **THR REF** and the thrust limit is takeoff.

② Sensed Engine Failure

Condition: After VNAV has engaged, engine failure is sensed, after takeoff, aircraft below engine out acceleration height and below the thrust reduction point entered on the TAKEOFF REF page.

Result: VNAV remains in **VNAV SPD** and commands a speed of $V_2 + 15$. Autothrottle remains in **THR REF** and the thrust limit remains takeoff (TO).

③ EO SID

Condition: Flaps extended and an engine out standard instrument departure (EO SID) is in the FMC database.

Result: The FMC loads the EO SID as a flight plan modification. The modification may be either executed or erased.

④ Acceleration Height

Condition: At acceleration height or flap retraction has started.

Result: VNAV commands an acceleration to $V_{REF} + 80$, limited by the aircraft configuration (flap placard). Pushing the VNAV function key shows the ACT $V_{REF} + 80$ CLB page.

⑤ Thrust Reduction

Condition: Aircraft has accelerated to the commanded $V_{REF} + 80$ speed.

Result: Thrust is automatically reduced from takeoff (TO) to continuous (CON) thrust. If the engine failure occurs above the thrust reduction point, the current climb thrust is maintained.

⑥ VNAV Climb (Engine Out)

Condition: Select the **ENG OUT>** prompt on the VNAV CLB page to show the applicable engine out performance data. The airline company engine out company speed (CO SPD) or long range cruise (LRC) speed may be selected. Execute to make the data active.

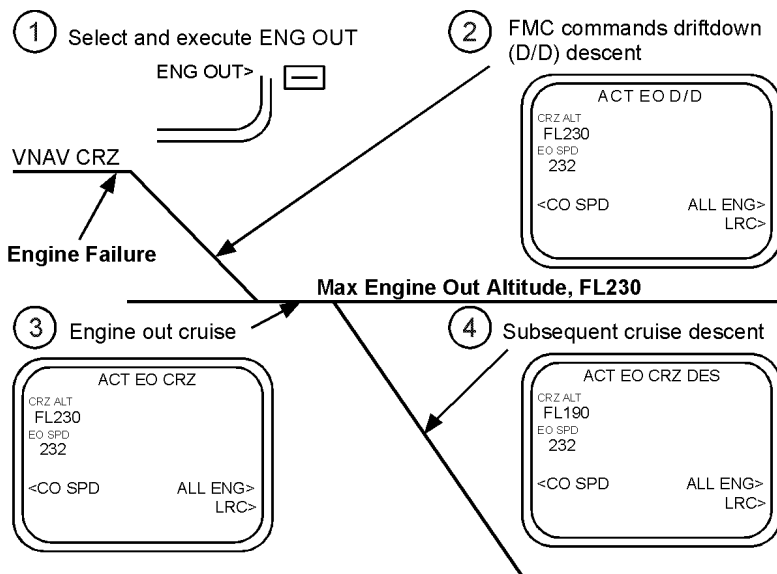
Result: The FMC engine out climb function is active, VNAV is in **VNAV SPD**, CON thrust is selected, if not previously selected. A different thrust limit may be selected on the THRUST LIM page.

Climb (Engine Out above EO Max Alt)

Selection of the **ENG OUT>** prompt on the VNAV CLB page, when the airplane is above the engine out maximum altitude, creates a modification and shows the applicable engine out driftdown (D/D) performance data to enable the airplane to descend to the engine out maximum altitude. Execution of the modification makes the engine out driftdown function active.

Cruise (Engine Out Above EO Max Alt)

Selection of **ENG OUT>** may also be accomplished on the XXXX ALTN page in conjunction with a diversion modification.



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① Engine Out Modification

Condition: Select the **ENG OUT>** prompt on the VNAV CRZ page.

Result: Creates a modification and shows the applicable engine out driftdown (D/D) performance data to enable the airplane to descend to the engine out maximum altitude.

② Drift Down Execution

Condition 1: Set the MCP altitude at or below EO MAX altitude and execute the FMC modification. This condition assumes clearance is approved to descend slowly to a non-standard altitude; for example, FL233.

Result: The reference thrust limit becomes CON, VNAV commands a very shallow descent in VNAV SPD as the airplane decelerates to EO SPD, the EO MAX altitude becomes the cruise altitude at 1L, and the autothrottle sets CON thrust on the operative engine. Time and distance for the D/D to EO MAX altitude display at 2R.

Two other ways to activate the EO D/D (to the clearance altitude) are discussed below.

Condition 2: Execute the ENG OUT modification. Then, set the clearance altitude (lower than EO MAX) in the MCP and push the MCP altitude selector.

Result: The airplane remains at the MCP altitude until the altitude is set lower and the MCP altitude selector is pushed, the pitch mode initially changes to VNAV ALT, the reference thrust limit becomes CON, and the autothrottle adjusts thrust on the operative engine to maintain FMC-commanded EO SPD. After setting the MCP altitude window and pushing the altitude selector, the operative engine increases thrust to CON and the airplane descends in a VNAV SPD driftdown to the clearance altitude in 1L. Initial descent rate is low, depending on the gross weight and on how much the airspeed has decreased before pushing the altitude selector. If the airspeed has decreased below EO SPD, the descent rate increases to regain the airspeed.

Condition 3: Set the clearance altitude (lower than EO MAX) in the MCP, push the altitude selector; then, after the descent is established, execute the FMC modification (ENG OUT selection).

Result: After pushing the altitude selector, the airplane descends in a normal VNAV SPD cruise descent at two-engine cruise speed. The reference thrust limit is CLB/CRZ and the autothrottle maintains cruise descent airspeed. The cruise altitude is set to the MCP altitude when the altitude selector is pushed. Executing the FMC modification while above EO MAX altitude sets the driftdown descent airspeed to EO SPD. The reference thrust limit becomes CON and the autothrottle increases thrust to CON on the operative engine. The airplane initially descends at economy cruise airspeed and approximately 1,250 fpm. After executing the ENG OUT modification, the commanded airspeed is EO SPD. The rate of descent decreases to a minimum of 300 fpm.

③ Engine Out Cruise

When VNAV captures the EO MAX altitude (Condition 1 only), the VNAV cruise page title becomes EO CRZ and the pitch annunciation is VNAV PTH, regardless of the MCP altitude window setting. Predictions for EO Step Climb display at 2R. Thrust limit remains in CON.

④ Subsequent Cruise Descent

Condition: FMC in engine out mode, more than 50 nm from T/D, set a lower MCP altitude, push the altitude selector.

Result: VNAV cruise descent at approximately 1250 fpm at EO SPD.

When the EO cruise descent intersects the planned descent profile, descent mode becomes active.

Required Time of Arrival (RTA)

VNAV controls cruise speed to arrive at a specified waypoint within ± 30 seconds of a specified time. The FMC shows the scratchpad message, **UNABLE RTA**, if the RTA is not achievable.

DATA ENTRY RULES

Altitude Entry

Altitudes can be entered into the FMC as three-digit (xxx), four digit (xxxx), five-digit (xxxxx), or flight level (FLxxx) numbers. The FMC automatically shows altitude or flight level entries in the proper form based on the transition altitude. Some data lines further restrict the valid entry forms.

Three digit entries represent altitude or flight levels in increments of 100 feet. Leading zeros are required.

Examples of three digit (xxx, FLxxx) entries with transition altitude = 10,000 feet:

- 800 feet is entered as 008 or FL008 and shown as 800
- 1,500 feet is entered as 015 or FL015 and shown as 1500
- 11,500 feet is entered as 115 or FL115 and shown as FL115
- 25,000 feet is entered as 250 or FL250 and shown as FL250.

Four digit entries represent feet, rounded to the nearest ten feet. Leading zeros are required. This form is used when the altitude does not exceed 9,994 feet.

Examples of four digit (xxxx) entries with transition altitude = 18,000 feet:

- 50 feet is entered as 0050 and shown as 50
- 835 feet is entered as 0835 and shown as 840
- 1,500 feet is entered as 1500 and shown as 1500
- 8,500 feet is entered as 8500 and shown as 8500
- 9,994 feet is entered as 9994 and shown as 9990.

Five digit entries represent feet, rounded to the nearest ten feet. This form is used when the altitude exceeds 9,994 feet.

Examples of five (xxxxx) digit entries with transition altitude = 4,000 feet:

- 50 feet is entered as 00050 and shown as 50
- 835 feet is entered as 00835 and shown as 840
- 1,500 feet is entered as 01500 and shown as 1500
- 8,500 feet is entered as 08500 and shown as FL085
- 9,995 feet is entered as 09995 and shown as FL100
- 11,500 feet is entered as 11500 and shown as FL115
- 25,000 feet is entered as 25000 and shown as FL250.
- Negative altitude entries are allowed to -1000 feet.

Airspeed Entry

Airspeeds can be entered into the FMC as calibrated airspeed, CAS, or Mach number, M. Calibrated airspeeds are entered as three digits (xxx) in knots. Mach numbers are entered as one, two, or three digits following a decimal point.

Data Pairs

Many CDU pages show data in pairs separated by a slash (/). Examples of these pairs include wind direction/speed and waypoint airspeed/altitude constraints. When entering both values in a pair, the slash is inserted between the values. When it is possible to enter only one value of the pair, the slash may not be required. When entering only the outboard value of a pair, the trailing or leading slash may be entered, but is not required before transferring to the data line. When entering the inboard value of a pair, the trailing or leading slash must be entered before transferring to the data line. Omission of the required slash normally results in an **INVALID ENTRY** message.

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FLIGHT MANAGEMENT COMPUTER

FMC Databases

The FMC contains three databases:

- Performance database
- Navigation database
- Airline Modifiable Information (AMI).

The performance database supplies all the necessary performance data to the flight crew. It supplies the FMC with the necessary data to calculate pitch and thrust commands. All necessary data can be shown on the CDU. The database includes:

- Airplane drag and engine characteristics
- Maximum and optimum altitudes
- Maximum and minimum speeds.

The crew can enter correction factors for drag and fuel flow to refine the database.

The navigation database includes most data usually found on navigation charts. This data can be shown on the CDU or ND. The database contains:

- The location of VHF navigation aids
- Airports
- Runways
- Other airline selected data, such as SIDs, STARs, approaches, and company routes
- Transition altitudes.

The FMC contains two sets of navigation data, each valid for 28 days. Each set corresponds to the usual navigation chart revision cycle. The FMC uses the active data for navigation calculations. The contents of the navigation database are periodically updated and are transferred to the FMC before the expiration date of the active data.

The AMI file contains airline specified data. If the FMC senses a conflict in an AMI value after a new AMI data load, the scratchpad shows the message **CHECK AIRLINE POLICY**.

Thrust Management

The autothrottle is controlled by the thrust management function. The thrust management function operates the autothrottle in response to flight crew mode control panel inputs or to automatic FMC commands. Reference thrust can be selected on the THRUST LIM page. Automatic FMC autothrottle commands are made while VNAV is engaged. Thrust management:

- Calculates reference thrust limits and thrust settings, or follows FMC thrust settings
- Commands the thrust levers
- Senses and transmits autothrottle failures
- Commands thrust equalization through the engine electronic controls.
- Thrust limits are expressed as N_1 limits. Thrust equalization references N_1 .
- Thrust management calculates a reference thrust for the following thrust settings:
 - TO - Takeoff
 - D-TO - Assumed temperature takeoff
 - CLB - Climb
 - CLB 1 - Climb one
 - CLB 2 - Climb two
 - CRZ - Cruise
 - CON - Continuous
 - G/A - Go-around.

With VNAV active, the reference thrust limit changes for the phase of flight. Thrust settings can be selected on the THRUST LIM page. The reference thrust limit displays above EICAS N_1 indications.

The flight crew can specify the thrust reduction height where the change from takeoff to climb thrust takes place by making an entry on the CDU TAKEOFF REF page. This can be an altitude from 400 feet to 9,999 feet, an entry of 1 for Flaps 1, or an entry of 5 for flaps 5.

Reduced Thrust Takeoff

Reduced thrust takeoffs lower EGT and extend engine life. They are used whenever performance limits and noise abatement procedures permit.

Assumed Temperature Thrust Reduction Takeoff

Entering an assumed temperature higher than the actual temperature reduces takeoff thrust.

The maximum thrust reduction authorized is 25 percent below any certified rating. Do not use assumed temperature reduced thrust if conditions exist that affect braking, such as slush, snow, or ice on the runway, or if potential windshear conditions exist.

The assumed temperature thrust setting is not considered a limitation. The assumed temperature reduction can be removed. If conditions are encountered where more thrust is necessary, the crew can manually apply full thrust.

Derated Thrust Climb

During climb, CLB 1 and CLB 2 derates are gradually removed. In cruise, the thrust reference defaults to CLB. The reference can be manually selected on the THRUST LIM page.

Two fixed climb thrust derates can be selected on the THRUST LIM page. CLB 1 uses a constant 10% derate of maximum climb thrust to 10,000 feet then increases thrust with altitude linearly to 12,000 feet. CLB 2 consists of a 20% derate of maximum climb thrust to 10,000 feet, then increases thrust linearly to maximum climb thrust at 12,000.

Use of an assumed temperature reduced thrust takeoff affects automatic selection of climb derate. For a thrust reduction of up to 5%, maximum climb thrust is automatically selected by the FMC. For takeoff thrust reductions from 5% to 15%, CLB 1 is selected. CLB 2 is selected for all takeoff thrust reductions greater than 15%. On the ground, the pilots may override the automatic climb derate selection after the takeoff selection is complete.

Use of derated climb thrust reduces engine maintenance costs, but increases total trip fuel.

Fuel Monitoring

The FMC receives fuel data from the fuel quantity system or from manual entries. Fuel quantity values are shown on the PERF INIT page as calculated (CALC), MANUAL, or SENSED. They are shown on PROGRESS page 2/3 as TOTALIZER and CALCULATED. TOTALIZER and SENSED values are the same data with different names.

The FMC usually uses the calculated value for performance computations. Before engine start, the calculated value is set to agree with the fuel quantity indicating system value. When the FMC receives a positive fuel flow signal at engine start, the calculated value is independent of the fuel quantity system and decreases at the fuel flow rate.

During fuel jettison, the calculated value is set equal to the fuel quantity system value. When fuel jettison is completed, the calculated value is independent of the fuel quantity indicating system and decreases at the fuel flow rate. This fuel quantity value is shown as CALC (calculated) on the PERF INIT page and CALCULATED on PROGRESS page 2/3.

If the flight crew inputs a fuel quantity, the line title changes to MANUAL and replaces the calculated value. Like the calculated value, the manual value is updated by fuel flow rate.

The calculated value is invalid if fuel flow data is invalid. In this case the FMC uses the fuel quantity indicating system quantity for performance computations. The line title on the PERF INIT page changes to SENSED and is shown as TOTALIZER on PROGRESS page 2/3.

The fuel used by each engine is calculated with its related fuel flow signal. FUEL USED is shown on PROGRESS page 2/3. It is set to zero on the ground after engine shutdown, and when the FMC receives a positive fuel flow at the next engine start.

The scratchpad shows the message **FUEL DISAGREE-PROG 2/3** if the FMC calculates a large difference between the fuel quantity indicating system quantity and calculated value. The flight crew should select PROGRESS page 2/3, and select the fuel value for the FMC to use through landing.

The FMC continually estimates the fuel at the destination airport if the active route is flown. The CDU message **INSUFFICIENT FUEL** is shown if the estimate is less than the fuel reserve value entered on the PERF INIT page.

Note: FMC calculated fuel predictions assume a clean configuration. Flight with gear or flaps extended cause fuel prediction errors. Fuel predictions are accurate after the gear and flaps are retracted.

If the actual fuel temperature reaches the minimum value shown on the PERF INIT page, the EICAS advisory message **FUEL TEMP LOW** is displayed.

Loss of FMC Electrical Power

The FMC must have continuous electrical power to operate. When the electrical power is interrupted and returns, the FMC automatically restarts.

After the restart, the performance data shown on the PERF INIT page must be re-entered. The route previously in use is available but must be reactivated.

The flight crew must modify the active waypoint to engage LNAV. Selecting the applicable active waypoint and proceeding direct or intercepting a course to the waypoint allows LNAV activation.

FMC FAILURE

Single FMC Failure

The scratchpad shows the message **SINGLE FMC L** or **SINGLE FMC R** after loss of a single FMC. The EICAS shows the advisory message **FMC MESSAGE**. Crew action is not necessary to change to single FMC operation. LNAV and VNAV, if active, remain active and all flight plan and performance data is kept.

A software reset may occur while in single FMC operation. The active route becomes inactive, the performance data is erased, and LNAV and VNAV (if engaged) modes fail. To regain FMC operation, activate and execute the flight plan, enter the necessary performance data, and engage LNAV and VNAV.

Note: If the MENU page and the scratchpad message **TIMEOUT RESELECT** is shown, the FMC is no longer connected to the CDU. Selecting **<FMC** prompt connects the CDU to the FMC.

Dual FMC Failure

In the unlikely event that both FMCs fail, LNAV and VNAV will mode fail. The EICAS advisory message **FMC** is displayed. The CDUs automatically supply route data to the NDs, and one of the CDUs supplies LNAV guidance to the autopilot. LNAV can be reselected on the mode control panel. FMS alternate navigation using the CDUs is discussed in this section.

Dual FMC failure may inhibit the autothrottle system. If it is available, use it in conjunction with any valid autopilot roll and/or pitch mode.

Note: The MENU page is shown and the **<FMC** prompt is not shown in line 1. Push the LEGS function key to show the ALTN NAV LEGS page, PROG key to show the ALTN NAV PROGRESS page and the NAV RAD key to show the ALTN NAV RADIO page.

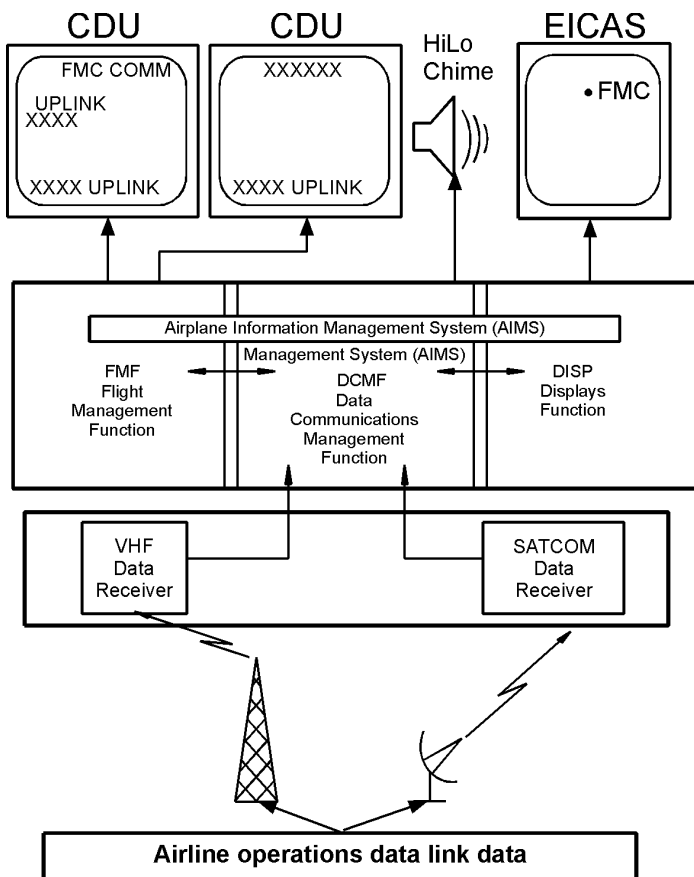
Air Traffic Control Data Link

Most Air Traffic Control data link functions are accomplished on the MFD. The CDU is used as an input keyboard for downlink message forms. Uplink messages, which contain route modifications, are loaded into the FMC using the LOAD FMC function on the MFD ATC page. Execution of an ATC loaded modification is accomplished using normal FMC modification procedures.

Refer to Section 6.5, Communications, MFD Communications, for a description of ATC data link.

Company Data Link

The airplane communications system enables two-way data link communications between the FMC and airline operations. A downlink occurs when data is transferred from the FMC and transmitted through the airplane communications system to a receiver on the ground. Data may be downlinked from the FMC either manually or automatically. An uplink is the opposite of a downlink; data is transmitted from a ground station for input to the FMC. Data may be uplinked at the discretion of the airline operations dispatcher or in response to a downlink request.



Data Link

Downlinks are data link message transmitted to a ground station. Requests for data and reports of FMC data are two types of downlinks. Requests are made manually by the flight crew. Reports can be made manually or may occur automatically.

Uplinks are messages transmitted to the airplane. Most uplinks require manual selections by the flight crew. Some uplinks are input automatically.

Manual Downlinks

Select a **REQUEST** prompt to start the downlink request for data. **REQUEST** prompts are on PERF INIT, TAKEOFF REF, DESCENT FORECAST, RTE, ALTN, ALTN LIST, or RTE DATA pages. Downlink reports of the active route may be accomplished by selection of the **REPORT** prompt on the RTE page and a position report may be downlinked by selection of the **REPORT** prompt on the POS REPORT page.

When the communications function is unable to prepare FMC downlinks, the words **FAIL**, **NO COMM**, or **VOICE** are shown on the CDU pages in place of the **REQUEST** and **REPORT** prompts. The data link status is also shown on the FMC COMM page. Radios supporting data link operations can be reconfigured by the crew through the MFD COMM function; refer to Section 6.5, Communications. The status messages are:

- **FAIL** -
 - The AIMs data communications management function is inoperative, or
 - Both the VHF and SATCOM data radios have failed.
- **NO COMM** -
 - The VHF and SATCOM data radios are operational but not available,
 - The VHF data radio has failed and the SATCOM data radio is not available, or
 - The SATCOM data radio has failed and the VHF data radio is not available.
- **VOICE** - All available radios are operating in the VOICE mode.

Reports

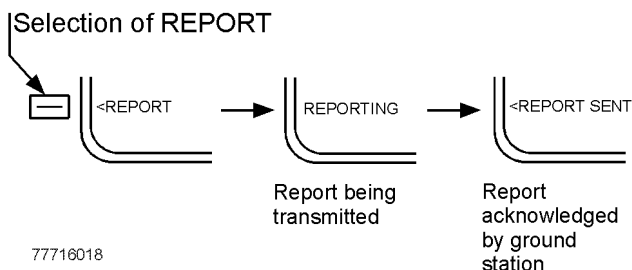
A **REPORT** prompt on each page downlinks a unique report applicable to that page. The pages below contain report prompts.



77716017

Report Status

Below is a typical sequence of status in response to sending a report.



77716018

Automatic Downlinks

The FMC can be configured by the airline to automatically transmit downlinks of FMC data at predetermined points during the flight or in response to specific data requests from the airline dispatcher. The FMC response in these cases is completely automatic and no flight crew action is necessary.

Uplinks

Uplinked data may be loaded automatically or may require flight crew action. Two uplinks automatically load data into the FMC and do not require execution. Uplinked data that waits in system memory for flight crew action are considered to be pending.

A pending uplink is included or discarded when the flight crew selects the applicable prompt. Flight crew response to an uplink depends on the type of uplink. Flight crew action is made with **ACCEPT/REJECT** or **LOAD/PURGE** prompts, FMC modification **ERASE** prompt or EXEC key, or when the page with the uplink is selected. Glareshield-mounted accept and reject switches operate the same as the CDU **ACCEPT/REJECT** prompts.

Data can be uplinked from the airline system directly to the PERF INIT, TAKEOFF REF, DESCENT FORECAST, RTE, ALTN WX, and WIND pages. The uplinks are annunciated to the crew by the **•FMC EICAS** communications alert and a HI-LO Chime. The uplink is identified by a CDU scratchpad message and by the presence of an **UPLINK** label over the applicable COMM page prompt.

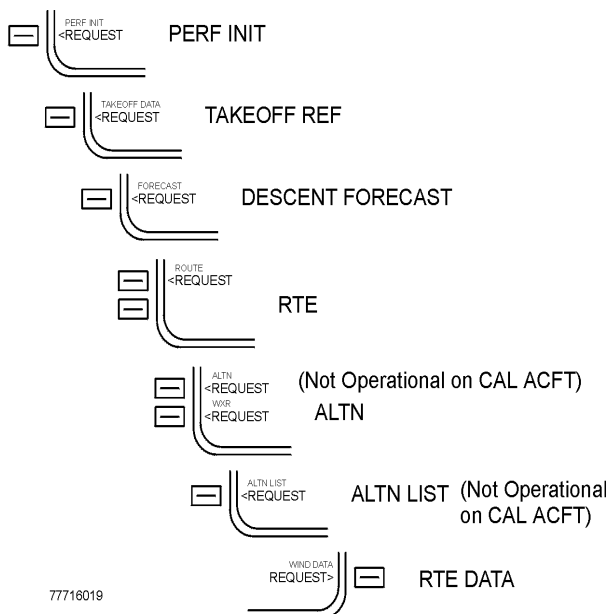
Takeoff uplinks are not annunciated until:

- Gross weight is entered on the PERF INIT page
- A route is activated
- The active route has a departure runway (and intersection, if applicable) matching the TAKEOFF uplinks (up to six takeoff records can be uplinked).

If there is no active route, wind uplinks are not annunciated, and the **<WIND** prompt on the COMM page is not shown.

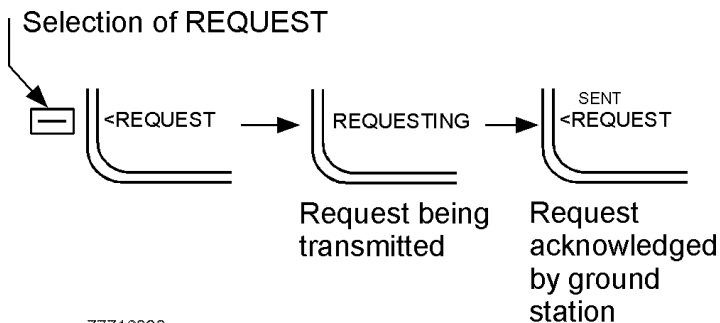
Requests

A **REQUEST** prompt on each page downlinks a unique request applicable to that page. The pages below contain request prompts.



Request Status

Below is a typical sequence of status in response to sending a request.



FMC Data Link Uplinks (Accept/Reject)

ACCEPT and **REJECT** are shown on the PERF INIT, TAKEOFF 1/2, and ALTN pages after receipt of uplink data.

Uplink data is shown initially in small font for preview.

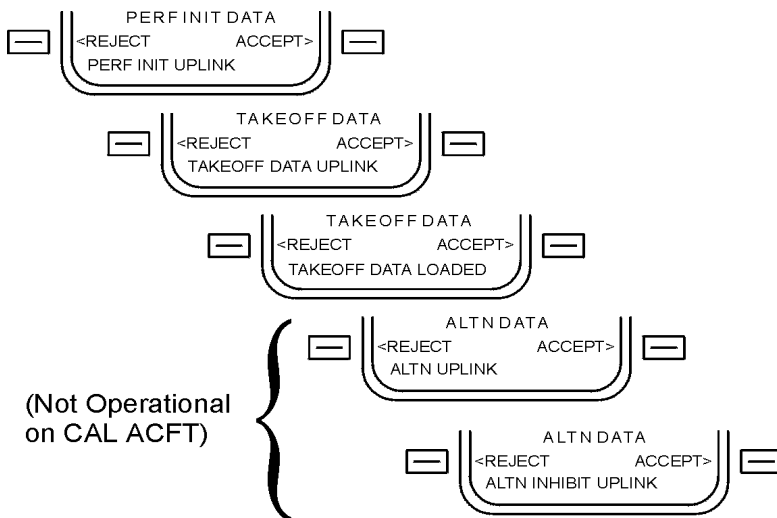
Select **ACCEPT** prompt:

- Shows uplinked data in large font
- Replaces previous data with uplinked data
- Page changes to pre-uplink format
- Clears scratchpad message
- Transmits a downlink accept message.

Select **REJECT** prompt:

- Replaces uplinked data with previous data
- Page changes to pre-uplink format
- Clears scratchpad message
- Transmits a downlink reject message.

FMC Data Link Uplinks (Load/Purge)



77716021

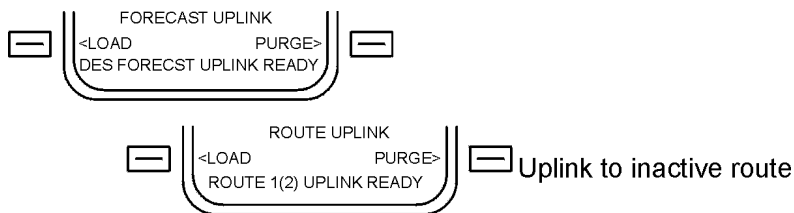
LOAD and **PURGE** are shown on the DESCENT FORECAST page after receipt of uplink data. **LOAD** and **PURGE** are shown on the active RTE 1 or RTE 2 page when there is an uplink to the inactive route.

Select **LOAD** prompt:

- Loads uplinked data into FMC for viewing
- Clears scratchpad message
- Replaces previous data with uplinked data
- Page changes to pre-uplink format
- Transmits a downlink accept message.

Select **PURGE** prompt:

- Replaces uplinked data with previous data
- Page changes to pre-uplink format
- Clears scratchpad message
- Transmits a downlink reject message.



77716022

FMC Data Link Uplinks (Load/Exec-Erase)

LOAD shows on the RTE and WIND pages after receipt of uplink data.

After the uplinked data is loaded, the **EXEC** light illuminates and the **ERASE** prompt is shown.

Select **LOAD** prompt:

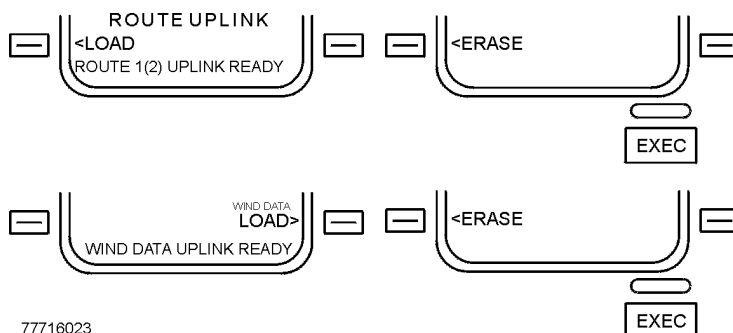
- Loads uplinked data into FMC
- Loaded data can be viewed
- Clears scratchpad message
- Replaces existing data with modified uplinked data
- Page title changes to MOD
- Shows **ERASE** prompt
- Illuminates **EXEC** light.

Push the **EXEC** key to:

- Put modified data in active flight plan
- Change page format to pre-uplink format
- Transmit a downlink accept message.

Select **ERASE** prompt to:

- Remove modified data
- Return page display to pre-uplink format
- Transmit a downlink reject message.

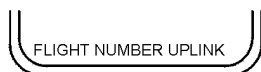


77716023

FMC Data Link Uplinks (Automatic)

FLT NO can be automatically uplinked and loaded. FLT NO automatically loads into the RTE 1/x page without flight crew action.

The scratchpad messages **FLIGHT NUMBER UPLINK** or **ALTN LIST UPLINK** stay in the scratchpad display queue until the applicable CDU page is selected.



77716024



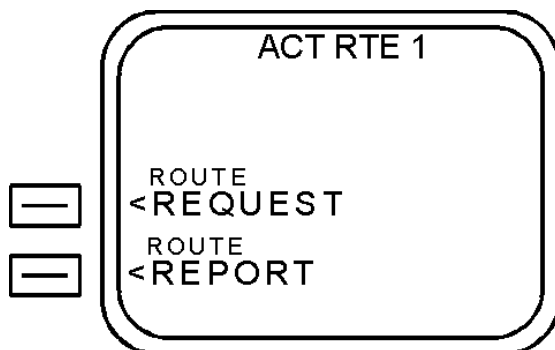
(Not Operational
on CAL ACFT)

DATA LINK MANAGEMENT

The flight crew should monitor system status of FMC data link. This is accomplished on various CDU pages or on the FMC COMM page. Changes to data link system operating modes area accomplished with the **COMM** function on the display select panel.

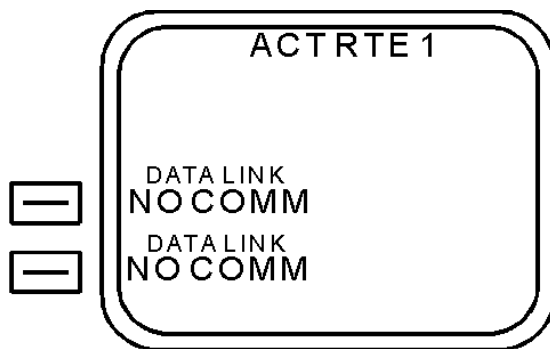
CDU Data Link Status Displays

Data link operation is verified when the correct line title is above the related prompt. In the example below, the line title **ROUTE** is above the **REQUEST** and **REPORT** prompts on the RTE page.



77716025

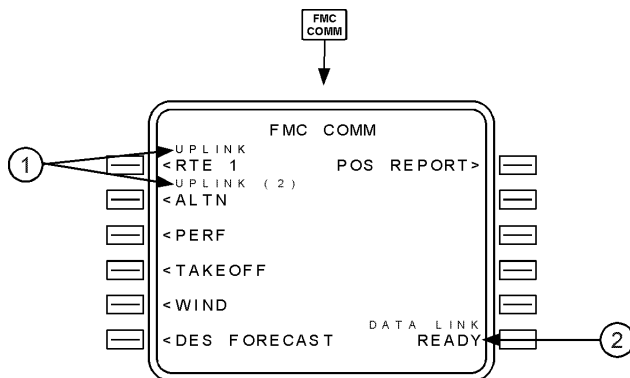
When the data link system is not operating, CDU page prompts change to **NO COMM** and the line titles change to **DATA LINK**.



77716026

FMC Communications Page

General data link status is shown on the FMC COMM page. Page select prompts are shown for each FMC page with access to data link data.



77716027

① Unlink Status

The page line heading shows **UPLINK** when an uplink message is pending and all preprocessing is complete. Preprocessing of uplinks makes sure all of the prerequisite data is available before the uplink message can be selected. Examples of preprocessing include:

- RTE, PERF, TAKEOFF, and WIND uplinks are held until route activation or modifications are complete.
- Subsequent uplinks of the same type are held until previous uplinks are included or discarded by the flight crew.
- TAKEOFF uplink is held until gross weight is entered, a pending PERF uplink is included or discarded, or a takeoff runway is entered.

When both ALTN and ALTN LIST uplinks are pending, (2) is shown to the right of UPLINK in the line heading. (Not operational on CAL ACFT.)

The EICAS message **-FMC** is shown whenever any **UPLINK** message is pending.

② Data Link

Shows the data link system status.

System status can be:

- READY
- NO COMM
- VOICE
- FAIL

Page Select Prompts

Selection of any of these prompts shows the related page:

- RTE 1 (2)
- ALTN
- PERF
- TAKEOFF
- WIND
- DES FORECAST
- POS REPORT

FMC PREFLIGHT

Introduction

FMC preflight is required before flight.

Completion of the FMC preflight requires data entry in all minimum required data locations. Entry of all required and optional preflight data optimizes FMC accuracy.

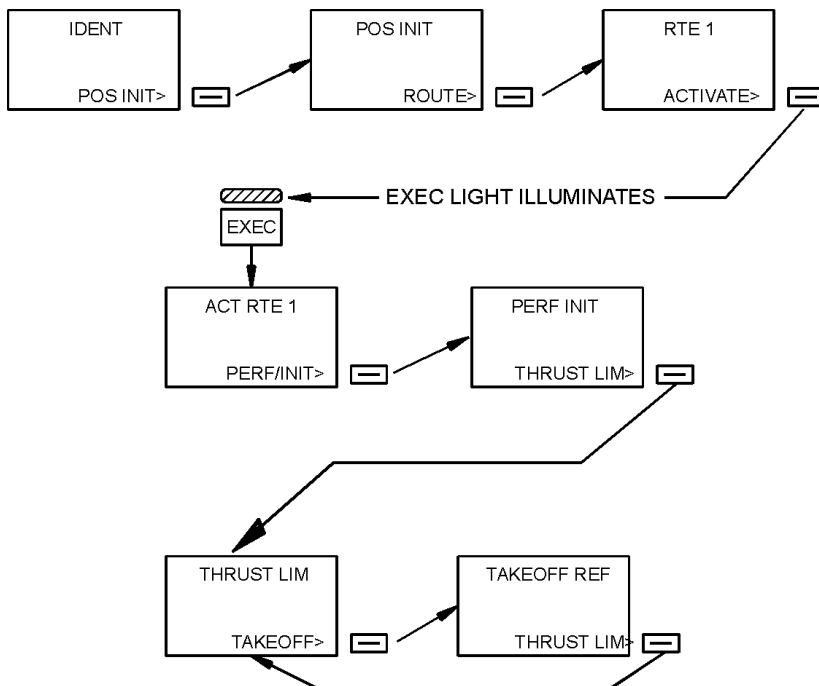
Data link can be used to load preflight data from airline ground stations. Using data link reduces the number of required flight crew actions. Manual flight crew entries replace existing data.

Data link can also be used to load takeoff data onto the TAKEOFF REF pages.

Preflight Page Sequence

The usual FMC power-up page is the identification page. Preflight flow continues in this sequence:

- Identification (IDENT) page
- Position initialization (POS INIT) page
- Route (RTE) page
- DEPARTURES page (no prompt)
- Navigation radios (NAV RAD) page (no prompt)
- Performance initialization (PERF INIT) page
- Thrust limit (THRUST LIM) page
- Takeoff reference (TAKEOFF REF) page
- Some of these pages are also used in flight.

Minimum Preflight Sequence

77716028

During preflight, a prompt in the lower right of the CDU page automatically directs the flight crew through the minimum requirements for preflight completion. Select the PROMPT key to show the next page in the flow. If a required entry is missed, a prompt on the TAKEOFF page leads the flight crew to the preflight page that is missing data.

Airplane inertial position is necessary for FMC preflight and flight instrument operation.

A route must be entered and activated. The minimum route data is origin and destination airports, and a route leg.

Performance data requires entry of airplane weights, fuel reserves, cost index and cruise altitude.

Takeoff data requires a flap setting and center of gravity.

Supplementary Pages

Supplementary pages are sometimes required. These pages must be manually selected. Manual selection interrupts the usual automatic sequence.

Discussions of each page include methods to show the page manually.

When the route includes SIDs and STARs, they can be entered into the preflight using the DEPARTURES or ARRIVALS pages.

Route discontinuities are removed, the route is modified, and speed/altitude restrictions are entered on the RTE LEGS page. The RTE LEGS page is described in the FMC Cruise in this section.

Alternate airports are added on the ALTN page. The ALTN page is described in the FMC Descent/Approach in this section.

Waypoints, navigation, airport, and runway data is referenced on the REF NAV DATA page. The REF NAV DATA page is described in the FMC Cruise in this section.

Fixed takeoff thrust derates can be changed on the AIRLINE POLICY page.

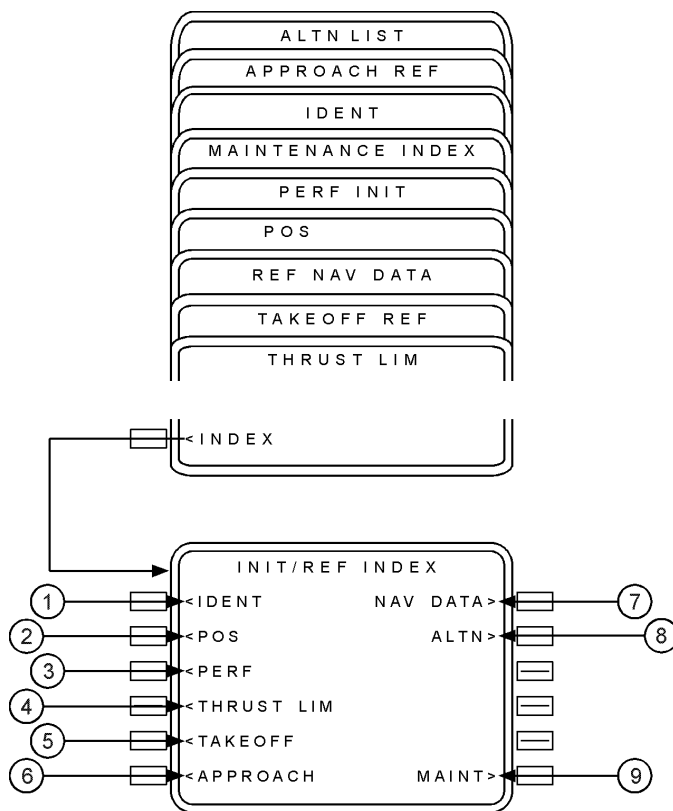
VNAV performance is improved if the forecast winds and temperatures are entered during the preflight. Wind and temperature data for specific waypoints are entered on the WIND page. The WIND page is described in the FMC Cruise in this section.

Preflight Pages - Part 1

The preflight pages are presented in the sequence used during a typical preflight.

Initialization/Reference Index Page

The initialization/reference index page allows manual selection of FMC pages. It gives access to pages used during preflight and not usually used in flight.



77716029

① Identification (IDENT)

The IDENT page is used to verify basic airplane data and currency of the navigation database.

② Position (POS)

The POS INIT page is used for ADIRU initialization.

The POS INIT page is also used for initialization of SAARU heading in the event the ADIRU fails.

③ Performance (PERF)

The PERF INIT page is used for initialization of data required for VNAV operations and performance predictions.

④ Thrust Limit (THRUST LIM)

The THRUST LIM page is used to select thrust limits and derates.

⑤ TAKEOFF

The TAKEOFF REF page is used to enter takeoff reference data and V speeds.

⑥ APPROACH

The APPROACH REF page is used for entry of the approach V_{REF} speed.

⑦ NAV DATA

The REF NAV DATA page is used for data on waypoints, nav aids, airports, and runways. NAV DATA pages are accessible only from this page.

⑧ Alternate (ALTN)

The ALTN page is used for alternate airport planning and diversions.

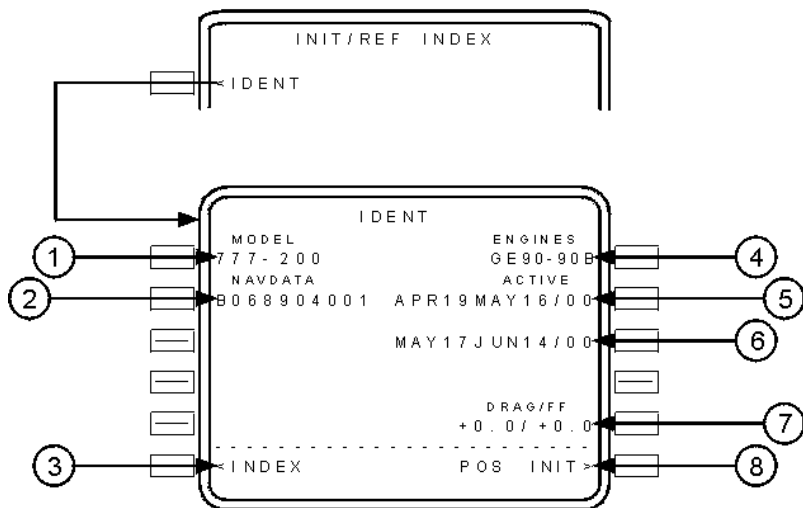
⑨ Maintenance (MAINT)

For maintenance use only; shows maintenance pages.

Identification Page

Most of the data on this page is for flight crew verification. Active date and drag / fuel flow accept manual entries.

The flight crew verifies FMC data, selects a navigation database, and checks or modifies drag and fuel flow factors on the identification page.



77716030a

①

MODEL

Shows the aircraft model.

②

NAV DATA

Shows the navigation database identifier.

③

INDEX

Push - Shows the INIT/REF INDEX page.

④

ENGINES

Shows the engine model and thrust rating. Header displays INTERMIX RATING for engine intermix installations.

⑤ **ACTIVE**

Shows the effective date range for the active navigation database.

The active navigation database may be out of date. It can be changed to the inactive navigation database. Push the date range prompt of the inactive navigation database to copy that date into the scratchpad. Push the date range prompt of the active navigation database to transfer the scratchpad date up to the ACTIVE database line. The previous active date moves down to the inactive date line.

The line title ACTIVE is above the active navigation database date. No line title is above the inactive navigation database date. The navigation database date can be changed only on the ground. Changing the navigation database removes all previously entered route data.

When an active database expires in flight, the expired database continues to be used until the active date is changed after landing.

⑥ **INACTIVE DATE RANGE**

Shows the affectivity date range for the inactive navigation database.

⑦ **DRAG/FF**

Shows the current aircraft drag and fuel flow correction factors.

Valid data range from -5.0 to +9.9.

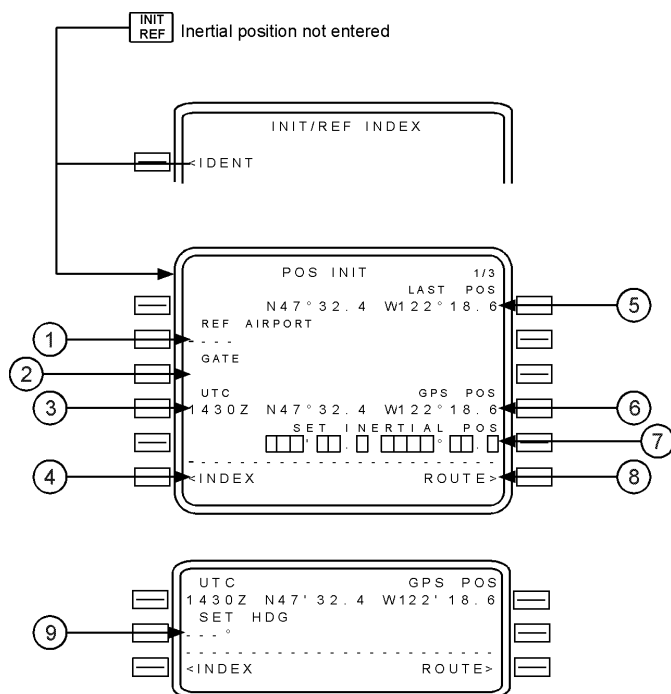
⑧ **Position Initialization (POS INIT)**

Push - Shows the POS INIT page.

Position Initialization Page 1/3

The position initialization page allows airplane present position entry for ADIRU alignment. The same page is used to enter the heading for SAARU initialization when the ADIRU is inoperative. There are three POS pages.

Data on the first page is used to initialize the ADIRU. In the event the ADIRU becomes inoperative in flight, initialization of the SAARU heading is accomplished on this page.



77716031

① **Reference Airport (REF AIRPORT)**

The reference airport entry allows entry of the departure airport to show the airport latitude/longitude.

Optional entry.

Valid entries are ICAO four letter airport identifiers.

Shows the latitude and longitude of the reference airport.

Removes previous GATE entry.

Entry blanks at lift-off.

② **GATE**

The gate entry allows further refinement of the latitude/longitude position.

Optional entry after the reference airport is entered.

Valid entry is a gate number at the reference airport.

Shows the latitude and longitude of the reference airport gate from the navigation database.

Changes to dashes when a new reference airport is entered.

Entry blanks at lift-off.

③ **Universal Time Coordinate (UTC)**

UTC (GPS) – Displays time from GPS.

④ **INDEX**

Push - Shows the INIT/REF INDEX page.

⑤ **Last Position (LAST POS)**

Shows the last FMC calculated position.

⑥ **GPS Position (GPS POS)**

Displays the GPS present position. During preflight, the **GPS POS** may not display due to satellite availability, performance, or unfavorable geometry.

⑦ **Set Inertial Position (SET INERTIAL POS)**

The set inertial position entry is required to initialize the ADIRU. Select the most accurate latitude/longitude from LAST POS, REF AIRPORT, GATE, GPS POS, or a manual entry to initialize the ADIRU.

If an entry is not made before the ADIRU finishes the initial alignment, the scratchpad message **ENTER INERTIAL POSITION** is shown.

If an entered position fails the ADIRU internal check, the scratchpad shows the message **ENTER INERTIAL POSITION**. If the manually entered position fails the ADIRU check after the position is entered a second time, the scratchpad message **ALIGNMENT REINITIATED** is shown.

The entered position is also compared with the FMC original airport position. If the entered position is not within 6 NM of the FMC original airport position, the scratchpad shows the message **INERTIAL/ORIGIN DISAGREE**.

Dashes are shown when the ADIRU is in the automatic realignment mode and can receive a new position update. Enter the most accurate inertial position to remove any accumulated ADIRU position errors.

Enter airplane position latitude and longitude.

Boxes are shown within one minute of ADIRU power-up.

Blanks when the ADIRU changes from the alignment to the navigation mode.

Blanks when the airplane is moving or has not been stationary for a minimum of six minutes.

Dashes are shown when the ADIRU enters the automatic realignment mode on the ground.

New inertial position entries can be made after dashes are shown during ADIRU automatic realignment. New entries are shown for 2 seconds. After 2 seconds, dashes are shown to allow entry of another position.

⑧ ROUTE

Push - Shows the ROUTE page.

⑨ SET HDG

Dashes display in flight when ADIRU is inoperative.

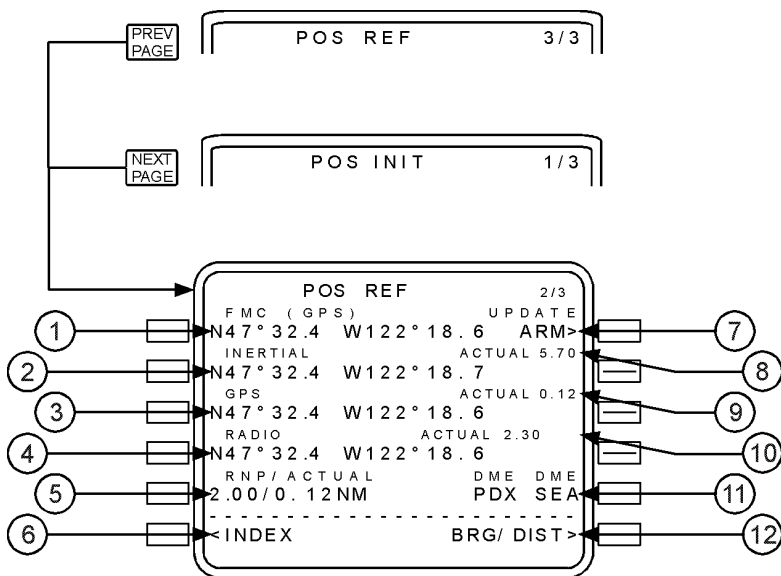
Entry of magnetic heading initializes SAARU.

Valid entry is 0 to 360 (0 or 360 displays as 360°). Entered heading displays in large font for two seconds, followed by dashes.

Position Reference Page 2/3

Position reference page 2 shows the positions calculated by the FMC, ADIRU, GPS, and radio navigation receivers. The FMC position can be updated to ADIRU, GPS, or radio position on this page.

This page shows latitude/longitude or bearing/distance. All position displays are in actual latitude and longitude, as calculated by the related system. The ADIRU, GPS, and radio position data can be changed to bearing/distance.



77716032

1 FMC

The source used by the active FMC for position data is shown next to the FMC line title. In the example, the FMC uses GPS for position data.

Shows the FMC calculated latitude/longitude.

Identifies the source for calculating the FMC position:

- **GPS** - The position is calculated from GPS position data
- **INERTIAL** - The position is calculated from ADIRU position data
- **RADIO** - The position is calculated from navigation radio position data.

② INERTIAL

Shows the latitude/longitude position as determined by the ADIRU.

③ GPS

Shows the latitude/longitude position as determined by the GPS.

④ RADIO

After airborne, shows the latitude/longitude position as determined by the navigation radios.

⑤ Required Navigation Performance and Actual Navigation Performance (RNP / ACTUAL)

Displays RNP values stored in the navigation database for departure and arrival procedures; or, if there are none, displays the default values stored within the FMC by flight phase. Also displays FMC actual navigation performance (ACTUAL).

Displays RNP values stored within the FMC by flight phase. Also displays FMC actual navigation performance (ACTUAL).

Default RNP is in small font.

Valid RNP entries are in the range 0.01 to 99.9. ACTUAL entry not allowed.

When ACTUAL exceeds RNP, the EICAS message **NAV UNABLE RNP** displays.

Note: The FMC stops GPS updating if GPS data accuracy degrades due to satellite availability or unfavorable geometry, or if the flight crew inputs a small RNP value. Subsequently, the FMC receives updates from another system.

⑥ INDEX

Push - Shows the INIT/REF INDEX page.

⑦ UPDATE ARM

Push -

- Arms the FMC position update function
- Changes the prompt to **ARMED**
- Adds **NOW** prompts to right side of INERTIAL, GPS, and RADIO lines.

Push a NOW prompt key to update FMC position to the selected source.

⑧ ACTUAL - INERTIAL

Shows the actual navigation performance of the ADIRU.

⑨ **ACTUAL - GPS**

Shows the actual navigation performance of the GPS.

⑩ **ACTUAL - RADIO**

Shows the actual navigation performance of radio updating.

⑪ **Radio Update Station(s)/Mode**

Shows the radio station identifiers.

Position update mode is indicated in the line title:

- **DME DME**
- **VOR DME.**

⑫ **Bearing/Distance (BRG/DIST) or Latitude/Longitude (LAT/LON)**

Push - Alternates the position data format between bearing/distance or latitude/longitude.

The page illustration is shown in the latitude/longitude display format.

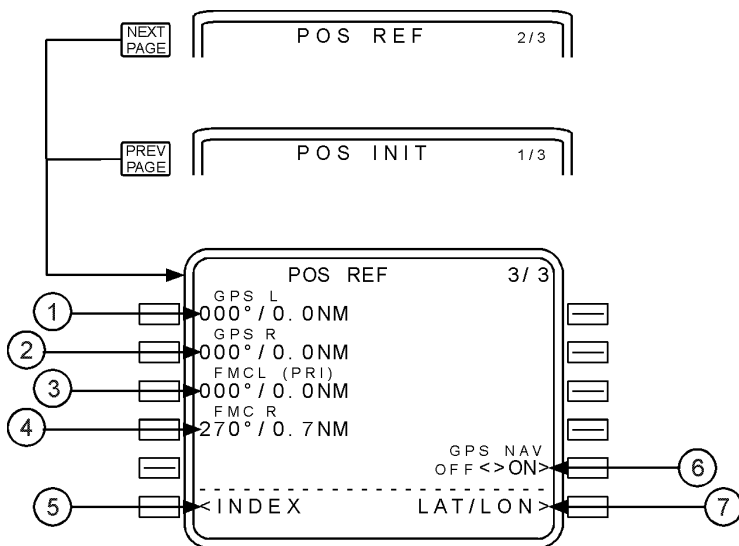
Latitude/longitude format displays are actual position.

Bearing/distance format shows the bearing and distance of the other position sources relative to the FMC position.

Position Reference Page 3/3

On position reference page 3, the flight crew can observe the calculated positions from the left and right GPS receivers and the left and right FMC calculations. This page also allows the flight crew to enable or disable GPS position updates.

This page can be shown in the bearing/distance or latitude/longitude format. The bearing/distance format shows the bearing and distance of the position sources relative to the active FMC position on the POS REF 2/3 page. In the example, both the left and right GPS agree with the left FMC position.



77716033

① GPS L

Shows the left GPS position.

② GPS R

Shows the right GPS position.

③ FMCL

Shows the left FMC calculated position.

Primary (**PRI**) is shown when the left FMC is active and the right FMC is inactive.

④ **FMC R**

Shows the right FMC calculated position.

PRI is shown when the right FMC is active and the left FMC is inactive.

⑤ **INDEX**

Push - Shows the INIT/REF INDEX page.

⑥ **GPS NAV**

Push - Alternately selects **GPS NAV ON** (enabled) and **OFF** (disabled).

OFF - GPS position data is not available to the FMC. **OFF** is shown in large green letters and **ON** is shown in small white letters.

ON - GPS position data is available to the FMC. **ON** is shown in large green letters and **OFF** shown is in small white letters.

Note: When power is initially applied to the airplane or when engines are shut down, **GPS NAV** is set to **ON**.

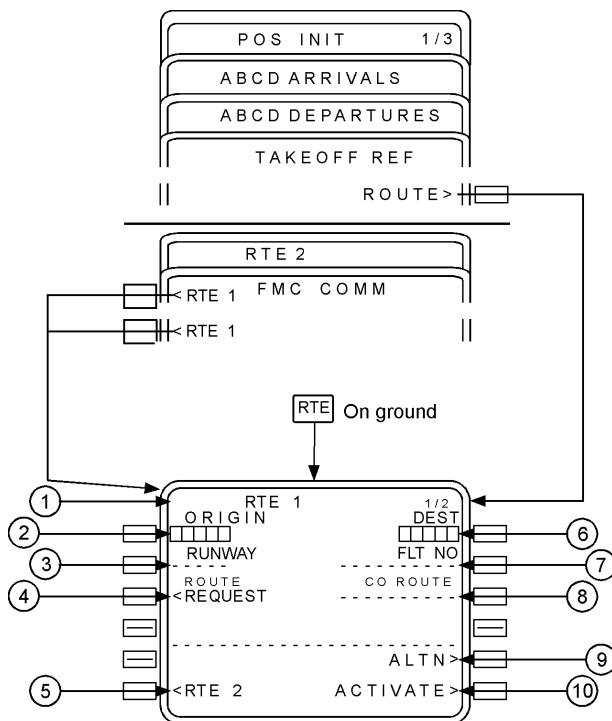
⑦ Latitude/Longitude (**LAT/LON**) or Bearing/Distance (**BRG/DIST**)

Push - Alternately changes the display of position data on POS REF 2/3 and 3/3 to latitude/longitude format or bearing/distance format.

The page illustration is shown in the bearing/distance display mode.

Route Page 1/X

Two routes (**RTE 1** and **RTE 2**) can be shown in air traffic control format. Routes can be entered by the flight crew or uplinked through data link. All routes have two or more pages. The first route page shows origin and destination data. Subsequent route pages show the route segments between waypoints or fixes. **ROUTE 1** and **ROUTE 2** allow management of alternate or future routes while leaving the active route unmodified. **ROUTE 2** has an identical page structure as **ROUTE 1**. When **RTE 2** is active, page display logic is the same as **RTE 1**.



77718034

① Page Title

White when the route is active.

Cyan when the route is inactive.

The white shaded word **MOD** is put to the left of the page title when the route is modified and the change is not executed.

Multiple route pages are indicated by the page sequence number to the right of the title. The minimum number of route pages is 2.

② **ORIGIN**

Entry:

- Must be a valid ICAO identifier in the navigation database.
- Is made automatically when a company route is entered.
- Enables direct selection of departure and arrival procedures.
- Is required for route activation.
- Shows **MOD** in page title of an active route.
- Entry on the ground deletes route; in flight, entries are valid on the inactive route.

③ **RUNWAY**

Enter the applicable runway for the origin airport. Runway must be in the navigation database. Entry is optional.

New entries on an active route cause **MOD** to show in the route title.

Automatically entered when part of a company route.

Can be selected on the DEPARTURES page.

FMC deletes runway after the first waypoint is crossed.

④ **ROUTE REQUEST**

Push - Transmits a data link request for a flight plan route uplink.

Flight crew can operationally fill in origin, destination, runway, flight number, company route name, or route definition to qualify request.

⑤ **RTE 2**

Push - Shows the RTE 2 page 1/x.

Allows access to an inactive route for creation and modification or activation.

Inactive route modifications do not alter the active route.

Prompt changes to **RTE 1** when **RTE 2** is shown.

⑥ Destination (DEST)

Entry:

- Must be a valid ICAO identifier in the navigation database.
- Is made automatically when a company route is entered.
- Enables selection of departure and arrival procedures.

⑦ Flight Number (FLT NO)

Enter the company flight number.

Entry is optional for activation of the route.

Limited to 10 characters.

Flight crew entered or uplinked.

Flight number is included in the PROGRESS page title.

Flight number can be entered on multifunction **COMM** display ATC LOGON page.

⑧ Company Route (CO ROUTE) (Not operational on CAL ACFT)

A company route can be called from the navigation database by entering the route identifier. The data supplied with a company route can include origin and destination airports, departure runway, SID and STAR, and the route of flight. All company route data is automatically entered when the route identifier is entered.

An entry is optional for activation of the route.

Enter a company route identifier.

Valid entry is any flight crew entered or uplinked company route name. If the name is not contained in the NAV database, the entry is allowed and the scratchpad message **NOT IN DATABASE** is shown.

Entry of a new company route replaces the previous route.

In-flight entry is inhibited for the active route.

⑨ Alternate (**ALTN**)

Push - Shows the ALTN page.

⑩ **ACTIVATE**

Push the **ACTIVATE** key to arm the route for execution as the active route. When the **EXECUTE** key is pushed, the route becomes the active route and the **ACTIVATE** prompt is replaced with the next required preflight page prompt.

Push - Prepares the selected route for execution as the active route.

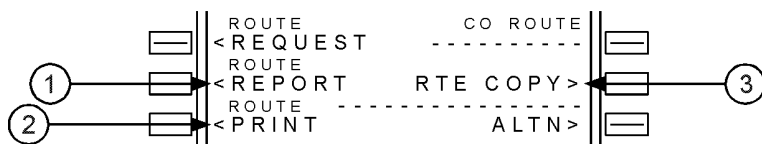
Activation of a route is required for completion of the preflight.

Shown on inactive route pages.

After route activation, the **ACTIVATE** prompt is replaced by:

- **PERF INIT**, when the required performance data is incomplete, or
- **TAKEOFF** when the required performance data is complete.

More Route Page Prompts for an Active Route



77716035

① **ROUTE REPORT**

Push - Transmits the active route to the company via data link downlink.

② **ROUTE PRINT**

Push - Sends the active route to the flight deck printer.

③ **Route Copy (RTE COPY)**

Push - Copies the entire active route (RTE x) into the inactive route (RTE y).

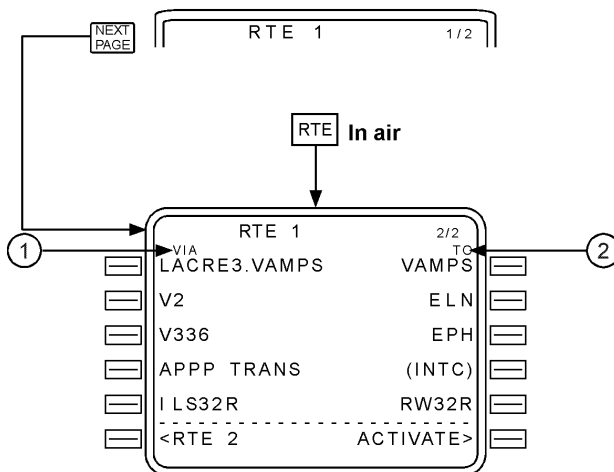
Shown only on the active route page.

Shows **COMPLETE** after the route is copied.

INTENTIONALLY LEFT BLANK

Route Page 2/X

The subsequent route pages 2/X through X/X, show the route segments in air traffic control format. Route segments are defined as direct routing, airways, or procedures with start and end points such as waypoints, fixes, nav aids, airports, or runways. More waypoints for each route segment are shown on the RTE LEGS page.



77716036

① VIA

The **VIA** column shows the route segment to the waypoint or termination shown in the **TO** column. Enter the path that describes the route segment between the previous waypoint and the segment termination.

Enter an airway in the **VIA** column and boxes are shown in the **TO** column.

Valid entries can also include procedures or **DIRECT**. Procedures are usually entered through selections on **DEPARTURES** and **ARRIVALS** pages. **DIRECT** is usually entered as a result of entering a **TO** waypoint first.

Valid airways must:

- Contain the fix entered in the **TO** waypoint, and
- Contain the previous **TO** waypoint, or
- Intersect the previous **VIA** route segment.

Dashes change to **DIRECT** if the **TO** waypoint is entered first.

Dashes are shown for the first VIA beyond the end of the route.

Invalid VIA entries show the scratchpad entry **INVALID ENTRY**.

Invalid VIA entries are:

- Airways and company routes which do not contain the TO waypoint of the previous line.
- Airways that do not intersect the previous airway.
- Airways or company routes that are not in the navigation database.

The start and end waypoints determine whether the entered airway is valid. The route segment must contain the waypoint entered in the TO position. The TO waypoint of the previous route segment must be the same as the start point of the next route segment or a route discontinuity is created between the segments.

Entry of a SID or transition automatically enters the VIA and TO data for the route segments of the SID. A SID automatically links to the next route segment when the final SID waypoint is part of the route segment.

When no SID is used, entering an airway on the first line of page 2 initiates an airway intercept from the runway heading and:

- Replaces the airway with dashes in the first line VIA.
- Shows boxes in the first line TO waypoint.
- Moves the airway to line 2 after the TO waypoint is entered.
- Enters the first fix on the airway nearest to being abeam of the departure heading in the airway line TO waypoint.

A route can contain segments formed by the intersection of two airways. Entering two intersecting airways in successive VIA lines without a TO waypoint causes the FMC to create an airway intersection waypoint to change from one segment to the next. The FMC created waypoint intersection (**INTC**) is automatically shown in the first airway segment TO waypoint.

LACRE3.VAMPS is an example of a SID selection made on the DEPARTURES page.

V2 and **V336** are examples of airway entries.

APP TRANS is an example of a STAR selection made on the APPROACH page.

ILS32R is an example of an approach selection made on the APPROACH page.

② **TO**

Enter the end point of the route segment specified by the VIA entry.

Entry of a waypoint in the **TO** column without first entering a VIA airway shows **DIRECT** in the **VIA** column.

Data input is mandatory when boxes are shown.

Valid waypoint entries for a DIRECT route segment are any valid waypoint, fix, navaid, airport, or runway.

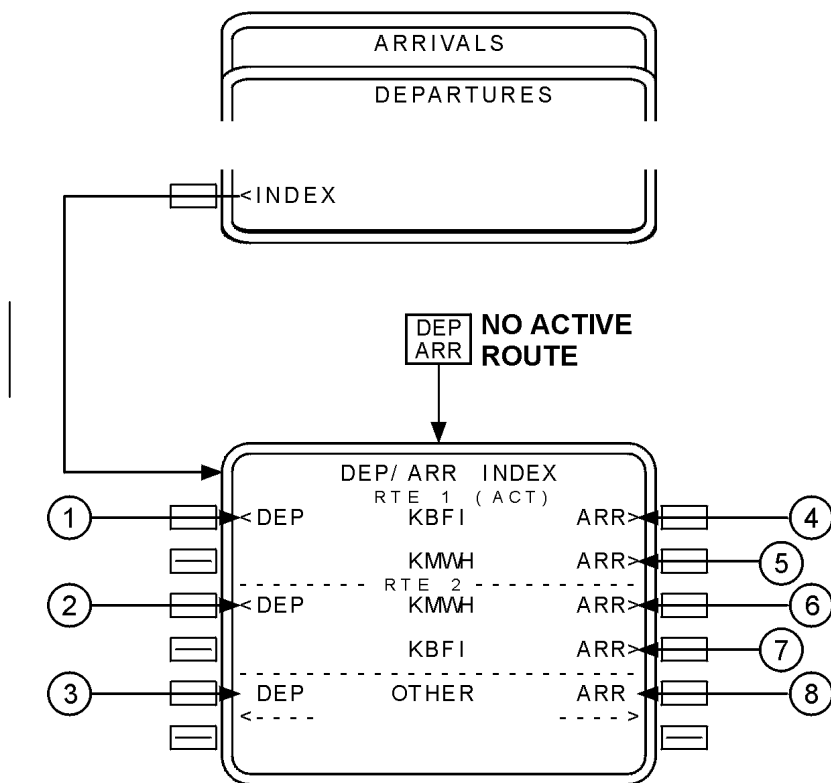
Valid waypoint entries for airways are waypoints or fixes on the airway.

Dashes are shown on the first TO waypoint after the end of the route.

Departure/Arrival Index Page

The departure and arrival index page is used to select the departure or arrival page for the origin and destination airports for each route. The index also allows reference to departure or arrival data for any other airport in the navigation database.

Departure and arrival prompts are available for the origin airport. Destination airports have only arrival prompts.



77716037

① Departure (DEP) - Route 1

Push - Shows the departure page for route 1 origin airport.

② Departure (**DEP**) - Route 2

Push - Shows the departure page for route 2 origin airport.

③ Departure (**DEP**) - Other

Shows the departure page for the airport entered into this line through the scratchpad.

DEP prompt for **OTHER** allow display of departure data about airports that are not an origin or destination. The data can be viewed but cannot be selected because the airport is not on the route.

④ Arrival (**ARR**) - Route 1 Origin

Push - Shows the arrival page for route 1 origin airport. Origin airport arrivals selection is used during a turn-back situation.

⑤ Arrival (**ARR**) - Route 1 Destination

Push - Shows the arrival page for route 1 destination airport.

⑥ Arrival (**ARR**) - Route 2 Origin

Push - Shows the arrival page for route 1 origin airport. Origin airport arrivals selection is used during a turn-back situation.

⑦ Arrival (**ARR**) - Route 2 Destination

Push - Shows the arrival page for route 1 destination airport.

⑧ Arrival (**ARR**) - Other

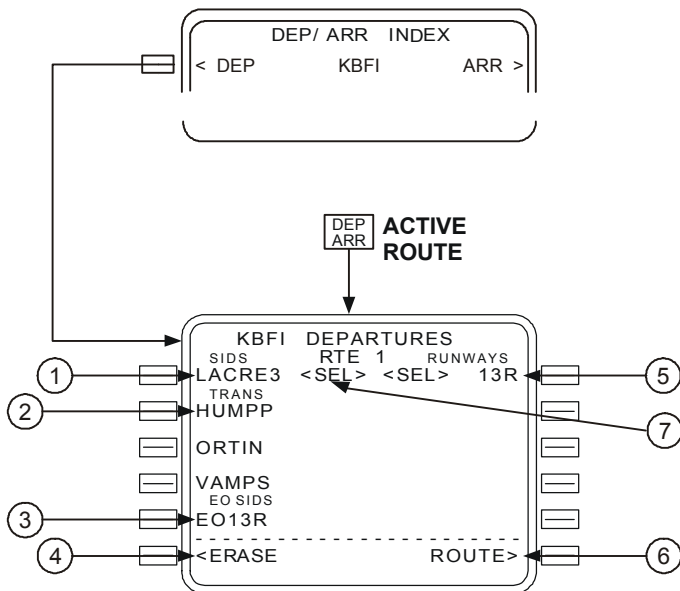
Shows the arrival page for the airport entered into this line through the scratchpad.

ARR prompt for **OTHER** allow display of arrival data about airports that are not an origin or destination. The data can be viewed but cannot be selected because the airport is not on the route.

Departures Page

The departures page is used to select the departure runway, SID, and transition for the route origin airport.

The departures page for the inactive route is shown when the **DEP ARR** function key is pushed with an inactive RTE or RTE LEGS page is shown.



77716038

① Standard Instrument Departures (**SIDS**)

Shows SIDS for the airport and runway selections.

Without the selection of a runway on the RTE 1/X page, the initial display contains all of the data for the airport runways and SIDS. As selections are made, incompatible options are removed. SID transitions are shown after a SID is selected.

② Transitions (**TRANS**)

Shows transitions compatible with the selected SID.

Push –

- Selects transition for entry in the route
- Other transitions no longer display.

③ Engine Out (EO) SIDS

Displays airline-defined single engine-out SIDS for selected airport. EO SID can be viewed before takeoff by line selecting and selecting the LEGS page. **EO SID** automatically selected during takeoff if an engine-out detected prior to “flaps up.” The modification can be either executed or erased. If an **EO SID** does not exit, **NONE** displays.

Push – Displays **EO SID** as the selected SID.

④ **ERASE** or **INDEX**

ERASE is shown when a route modification is pending. **INDEX** is shown when no route modification is pending.

ERASE push - Removes route modifications that are not executed and shows the original route.

INDEX push - Shows the DEP/ARR INDEX page.

⑤ **RUNWAYS**

Shows a list of runways for the selected airport.

The runway selected on the RTE 1/X page is shown as **<SEL>** or **<ACT>** when this page is shown.

Push –

- Selects runway for use in the route. All other runways no longer display.
- SIDS associated with selected runway remain, all others no longer display.
- Subsequent change of a runway deletes departure procedures previously selected.

⑥ **ROUTE**

Push - Shows the related RTE page.

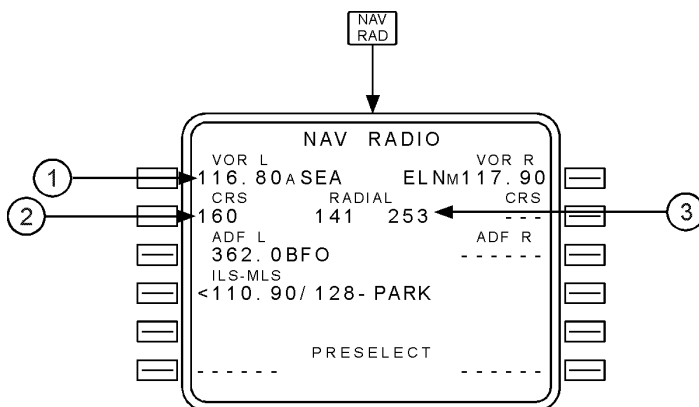
⑦ Selecting Options

Selecting an option shows **<SEL>** inboard of the option, and a route modification is created. When the modification is executed, the **<SEL>** becomes **<ACT>**. Leaving the page and returning shows all options and the **<SEL>** or **<ACT>** prompts.

Navigation Radio Page

VOR and ILS navigation radio tuning is normally automatic. ADF radios are manually tuned. The CDU NAV RADIO page shows the VOR, ILS, and ADF radio status and allows manual control of these radios. Entering data on this page manually tunes the selected navigation radio. Manually selected VOR courses can also be entered.

VOR



77716039

① VOR L and VOR R

Left and right VOR data are shown on the CDU. VOR tuning status is shown adjacent to the VOR frequency. The automatic tuning mode operates for procedure flying, and route operations. Enter the frequency or identifier to manually tune a VOR. VORs are tuned automatically by the FMC in the following priority:

- **P** - Procedure autotuning. The FMC selects navaids necessary for approach or departure procedure guidance.
- **R** - Route autotuning. The FMC selects navaids on the active route. The navaid must be the previous VOR or a downpath VOR within a certain range of aircraft position.
- **A** - Autotuning. The FMC selects the best available valid navaid.

An “M” shows the VOR is tuned manually. Manual tuning takes priority over FMC tuning.

Note: When magnetic variation at the airplane location and the VOR are far different, the ND VOR radial and ND POS green vector do not point directly to the VOR. This difference decreases as the airplane gets closer to the VOR.

Valid entries:

- VOR or non-ILS DME identifier or VOR frequency.
- VOR identifier or frequency/course; the course shows on the CRS line.

Tunes associated DME.

The identifier and frequencies are green and tuning status is white.

② **CRS**

VOR course is green. Radial is white.

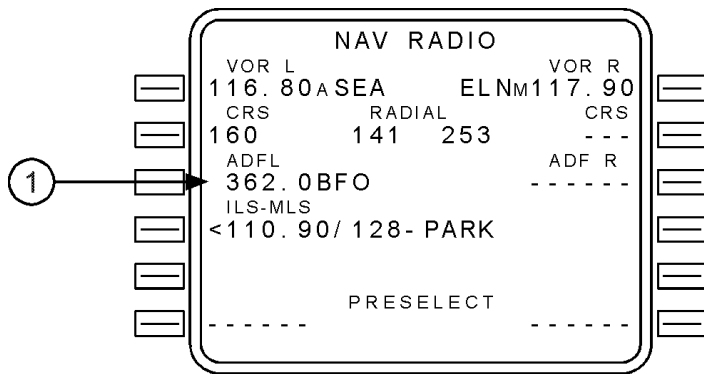
Blank when in autotune mode.

Valid entry is a three-digit course. Data can be entered when dashes are shown

③ **RADIAL**

Shows radial from left and right VOR stations to the airplane.

ADF



77716040

① ADF Frequency and Tune Mode

Left and right ADF data are shown. ADF tuning status is shown adjacent to ADF frequency. The tuning status displays are:

- **ANT** – Antenna mode for bearing data
- **BFO** - Beat Frequency Oscillator mode for audio data used during manual tuning.

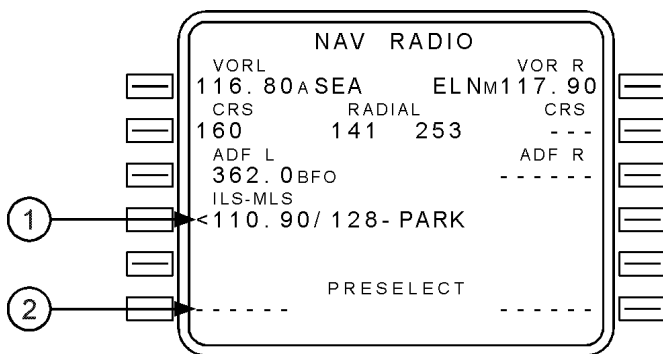
Default tuning mode is ADF (no indication) giving both bearing data and audio.

Valid entries are XXX.X or XXXX.X.

Manual entry can be followed by A (**ANT**), B (**BFO**), or none, which defaults to the ADF mode.

Frequency is cyan and status is white.

ILS



77716041

① ILS Frequency and Course

The ILS receivers operate in the automatic or manual tuning mode. The FMC commands the frequency and course selection in the automatic mode. When the ILS is not necessary, the FMC sets the ILS to **PARK**. This removes the displays from the PFD.

Airplane position on the route determines the ILS operating mode. The operating mode displays are:

- **PARK** - The ILS is not being used and is not tuned
- **XXX.XX/YYY PARK** - The ILS is tuned for the selected approach but is not being used
- **"A"** indicates autotuning under FMC control for approach guidance.

An **"M"** indicates the ILS is manually tuned.

ILS manual tuning requires entry of a frequency and course. Manual entry of a frequency without a course is not allowed. Manual tuning is inhibited when:

- The autopilot is engaged and either the localizer or glideslope is captured.
- Only the flight director is engaged and either the localizer or glideslope is captured and the airplane is below 500 feet radio altitude.
- On the ground with the localizer alive, the airplane heading within 45 degrees of the localizer front course and the ground speed is greater than 40 knots.

Manual ILS tuning is enabled when:

- Either TOGA switch is pushed
- The autopilot is disengaged and both flight directors are switched off
- The MCP approach switch is deselected when the airplane is above 1500 feet radio altitude.

Valid entries:

- ILS frequency and course (xxx.xx/yyy)
- Course, with a frequency and course already entered (/yyy).

② **PRESELECT**

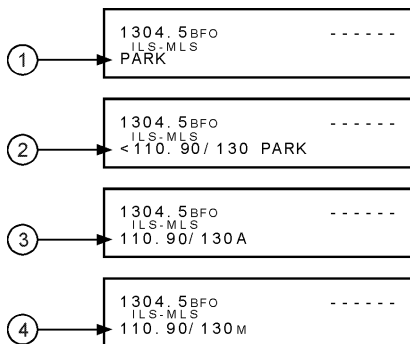
Any valid page data may be entered.

Put data into this line for later use. Data can be moved to the appropriate line when necessary.

ILS Tuning Mode

Airplane position on the route determines the ILS operating mode. The operating mode displays are:

- **PARK** - The ILS is not being used and is not tuned
- **XXX.XX/YYY PARK** - The ILS is tuned for the selected approach but is not being used
- **"A"** indicates autotuning under FMC control for approach guidance.
- **"M"** (manual) indicates ILS is manual-tuned.



77716042

① Tuning Mode - Park

PARK is shown when:

- Electrical power is first applied,
- More than 200 NM from the T/D, or
- Less than halfway to the destination.

② Tuning Mode - Frequency, Course, and Park

ILS frequency, front course, and **PARK** display when an ILS, LOC, back course, LDA (Localizer-type Directional Aid), or SDF (Simplified Directional Facility) is selected, and:

- Less than 200 NM from the T/D, or
- More than halfway to the destination, whichever represents the lesser distance to destination.

Select prompt to manually tune **ILS-MLS**.

③ Tuning Mode - Autotune

ILS frequency, front course and **A** are shown when:

- Less than 50 NM from the T/D
- Less than 150 NM from the runway threshold
- FMC is in descent mode.

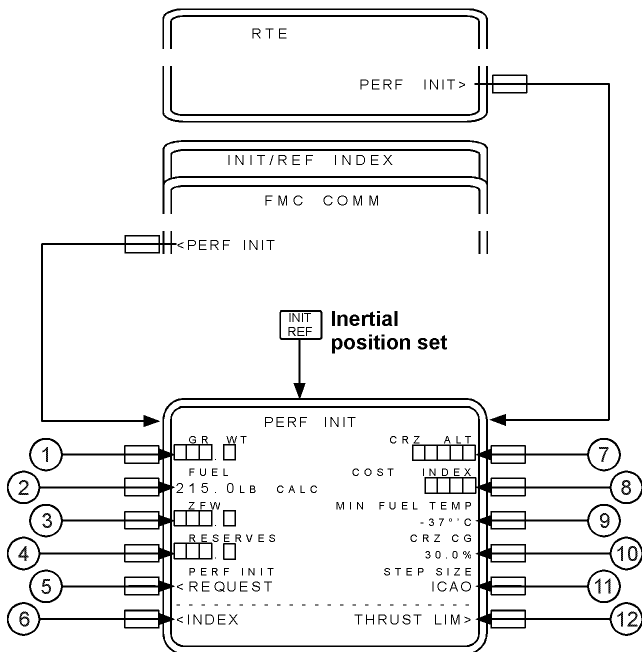
④ Tuning Status – Manual

Receiver tuned manually and valid frequency / course display.

Preflight Pages - Part 2

Performance Initialization Page

The performance initialization page allows the entry of airplane and route data to initialize performance calculations. This data is required for VNAV calculations.



77716043

① Gross Weight (GR WT)

Airplane gross weight is required. The entry can be made by the flight crew or automatically calculated by the FMC, after entry of zero fuel weight.

Enter airplane gross weight.

Valid entries are xxx or xxx.x.

Automatically shows calculated weight when zero fuel weight is entered first.

Entry of a value after takeoff speeds are selected removes the speeds and shows the scratchpad message **TAKEOFF SPEEDS DELETED**.

② FUEL

Fuel on board is automatically shown when the fuel totalizer calculations are valid. The source for the automatic display is included in the line:

- **SENSED** is shown when the source is from the airplane fuel totalizer and manual entry is not possible.
- **CALC** is shown when the source is from FMC calculations and manual entry is possible.
- **MANUAL** is shown when the source is from a manual entry.

Valid entry is XXX or XXX.X.

Unit of quantity is shown to the right of the numerical value.

Only manual entries can be deleted.

③ Zero Fuel Weight (ZFW)

Airplane zero fuel weight is required. Usually the ZFW is entered from the airplane dispatch papers and the FMC calculates the airplane gross weight.

Enter the airplane zero fuel weight.

Valid entry is xxx or xxx.x.

Calculated zero fuel weight is automatically shown if airplane gross weight is entered first and fuel on board is valid.

Entry of a value after takeoff speeds are selected removes the speeds and shows the scratchpad message **TAKEOFF SPEEDS DELETED**.

Can be manually entered or uplinked. When a performance uplink is pending, uplinked values (small font) are shown beside the entered values (large font).

④ RESERVES

Enter fuel reserves for the route.

Entry is required to complete the preflight.

Valid entry is xxx or xxx.x.

Can be manually entered or uplinked. When a performance uplink is pending, uplinked values (small font) are shown beside the entered values (large font).

⑤ Performance Initialization Request (**PERF INIT REQUEST**)

Transmit a data link request for performance data uplink.

Flight crew can operationally fill in ZFW, CG, cruise altitude, reserves, cost index, or fuel temperature to qualify request.

⑥ **INDEX**

Push - Shows the INIT/REF INDEX page.

⑦ Cruise Altitude (**CRZ ALT**)

Cruise altitude is required. The altitude can be entered by the flight crew or automatically entered from a company route or uplink.

Enter the cruise altitude for the route.

Automatically shows this cruise altitude on the CLB and CRZ pages.

⑧ **COST INDEX**

Cost index is used to calculate ECON climb, cruise and descent speeds. Larger values increase ECON speeds. Entering zero results in maximum range airspeed and minimum trip fuel. Cost index can be entered by the flight crew or from a company route or uplink.

Valid entries are 0 to 9999.

⑨ Minimum Fuel Temperature (**MIN FUEL TEMP**)

When actual fuel temperature reaches the value shown, the EICAS advisory message **FUEL TEMP LOW** is shown.

Shows minimum fuel operating fuel temperature.

Default value from the AIRLINE POLICY page is shown in small font.

Flight crew entered or uplinked value is shown in large font.

Valid entries are -99 to -1 in °C.

10 Cruise Center of Gravity (**CRZ CG**)

Used to compute the high and low speed maneuver Mach numbers in cruise.

Shows default center of gravity from the performance database.

Can be manually entered or uplinked.

Default value from the performance database is shown in small font.

A flight crew entered or unlinked value is shown in large font.

Valid entry is 14.0 through 44.0.

11 **STEP SIZE**

Shows the climb altitude increment used for planning the optimum climb profile.

The word **ICAO** is shown for the default value from the AIRLINE POLICY file.

Valid manual entries are 0 to 9000 in 1000 foot increments.

In-flight entries are inhibited. In-flight step size changes are made on the CRZ page.

For a non-zero entry, performance predictions are based on step climbs at optimum points. For a zero entry, performance predictions are based on a constant CRZ ALT.

12 Thrust Limit (**THRUST LIM**)

Push - Shows the THRUST LIM page.

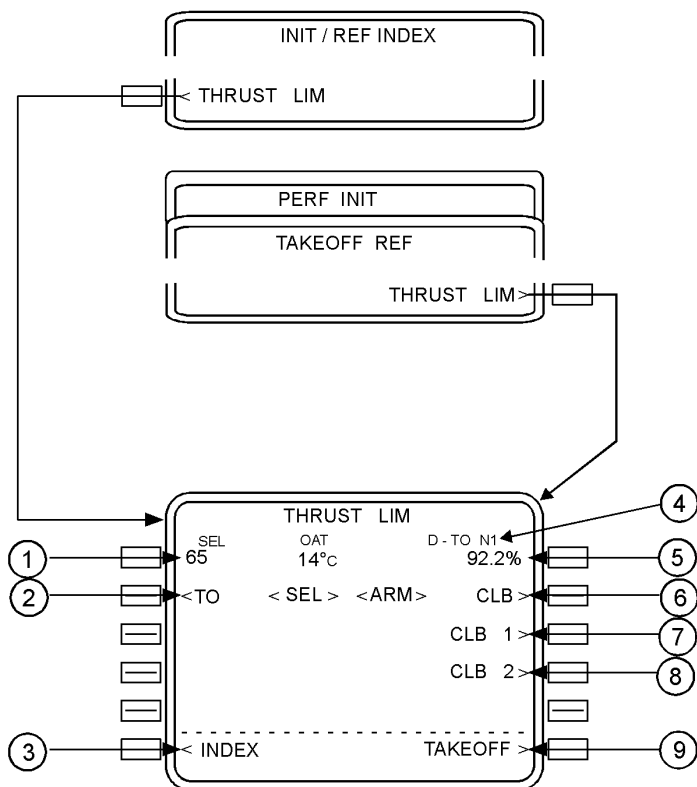
Thrust Limit Page

The thrust limit page allows selection and display of reference thrust in preparation for takeoff. Takeoff thrust derate by use of assumed temperature is also shown on this page.

More page data displays are:

- **<SEL>** - Identifies the selected takeoff or climb thrust reference mode.
- **<ARM>** - Identifies the armed climb thrust reference mode.

The **<ARM>** prompt changes to **<SEL>** when the armed climb mode becomes active.



① Assumed Temperature (**SEL**), Outside Air Temperature (**OAT**)

Initially blank. Displays entered assumed temperature up to the maximum thrust reduction limit.

Entry of an assigned temperature warmer than OAT reduces takeoff thrust and displays **D** as part of the thrust mode.

Valid entries are 0 to 99 degrees Celsius (C) or 32 to 210 degrees F.

Entry in degrees Fahrenheit (F) causes OAT to display degrees F.

Uplinked temperatures display on both the THRUST LIM and TAKEOFF REF pages.

Flight crew entered or uplinked values replace previously displayed values.

Entry of a value after takeoff speeds are selected deletes V speeds and displays the scratchpad message **TAKEOFF SPEEDS DELETED**.

OAT displays outside air temperature in degrees C. When SEL temperature is in degrees F, the OAT converts to degrees F.

② Takeoff (**TO**)

Push - Selects full rated takeoff thrust limit.

Selection of a new rating after takeoff speeds are selected removes the speeds and shows the scratchpad message **TAKEOFF SPEEDS DELETED**.

③ **INDEX**

Push - Shows the INIT/REF INDEX page.

④ Thrust Reference Mode

Displays selected takeoff thrust mode.

D displays when the takeoff thrust derate uses an assumed temperature.

⑤ Takeoff N1 Limit

Displays the takeoff N1 calculated by the thrust management system.

⑥ Climb (**CLB**)

Push - Selects the full rated (**CLB**) climb thrust limit.

Pushing a climb line select key overrides an automatic selection.

⑦ Climb 1 (CLB 1)

Push - Selects a percentage derate for climb thrust limit.

Default thrust derate for CLB 1 is not flight crew modifiable.

Takeoff data uplink automatically selects a thrust derate.

Manual selection of a climb thrust rating overrides the automatic selection.

⑧ Climb 2 (CLB 2)

Push - Selects a percentage derate for climb thrust limit.

Default thrust derate for CLB 2 is not flight crew modifiable.

Takeoff data uplink automatically selects a thrust derate.

Manual selection of a climb thrust rating overrides the automatic selection.

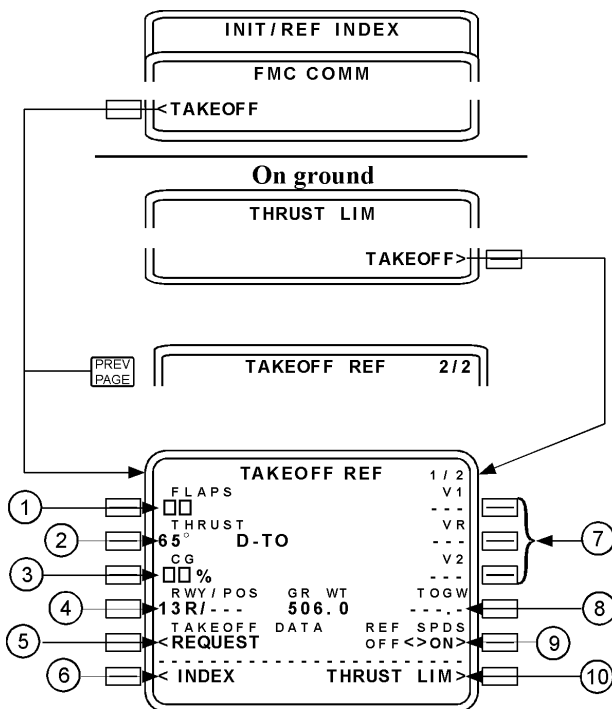
⑨ TAKEOFF

Push - Shows the TAKEOFF REF page.

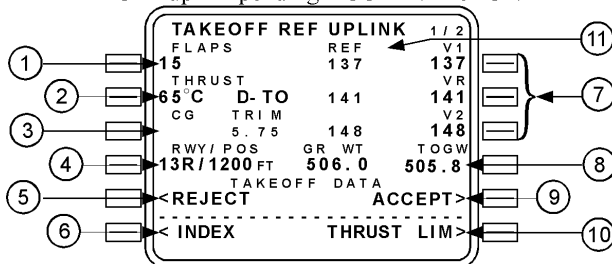
Takeoff Reference Page 1

The takeoff reference page allows the flight crew to manage takeoff performance. Takeoff flap setting and V speeds are entered and verified. Thrust limits, takeoff position, and takeoff gross weight can be verified or changed. Preflight completion status is annunciated until complete.

Takeoff reference page entries finish the normal preflight. The takeoff flap setting must be entered and V speeds should be set before completion.



CDU following line selection of REQUEST and receipt of TAKEOFF uplink pending ACCEPT/REJECT.



① FLAPS

Displays takeoff flap setting. Valid entries are 5, 15, or 20.

Flight crew entry or data link uplink.

Entry of 5 when FLAPS 5 is the climb thrust reduction point shows the scratchpad message **INVALID ENTRY**.

Flap position is required for takeoff V speed calculations.

Entry of a value after takeoff speeds are selected removes the speeds and shows the scratchpad message **TAKEOFF SPEEDS DELETED**.

② THRUST

Shows flight crew entered or uplinked assumed temperature for takeoff thrust derate calculations. Shows takeoff thrust selected on THRUST LIM page.

Valid entries are 0° to 99°C or 32° to 210°F.

Entry of a value after takeoff speeds are selected removes the speeds and shows the scratchpad message **TAKEOFF SPEEDS DELETED**.

③ Center of Gravity (CG) and TRIM

Boxes are shown until flight crew entry is accomplished.

Valid entry is within the valid range for the airplane.

After center of gravity is entered, the FMC:

- Calculates and shows stabilizer takeoff setting to the right of the CG entry (trim display is in 0.25 unit increments)
- Updates the takeoff green band shown on the stabilizer position indicators.

④ Runway/Position (**RWY/POS**)

Displays the selected takeoff runway, and TO/GA push distance from the runway threshold or runway intersection identification.

Displays the takeoff runway from the active RTE page if previously selected. Runway entry does not change runway entered on RTE or DEPARTURES page.

Flight crew may enter or uplink runway and intersection data.

Valid entry of a runway intersection is an alphanumeric up to three characters, preceded by a slash (/).

Valid position entry is a one or two numeric on the range 0 - 99. It must be followed by two zeros and preceded by a slash (preceding the entry with a “-” means a longer takeoff distance is available; for example, -0300 is 300 feet before the runway threshold).

Entry of a value after takeoff speeds are selected removes the speeds and shows the scratchpad message **TAKEOFF SPEEDS DELETED**.

RWY/POS update inhibited when GPS is primary FMC navigation source.

⑤ **TAKEOFF DATA REQUEST**
REQUEST

Push – Transmits a data link request for takeoff data uplink.

Flight crew can enter RWY, intersection or position shift, CG, TOGW, or OAT to qualify the request.

REJECT

Push – Rejects the takeoff data uplink and returns the **REQUEST** prompt.

⑥ **INDEX**

Push - Shows the INIT/REF INDEX page.

⑦ **V Speeds (V_1 , V_R , V_2)**

Displays dashes when:

- Required information not entered
- Performance calculations are inhibited
- ADIRU is not aligned.

Flight crew entry or uplink speeds replace calculated speeds.

Calculated speeds display in small font.

Push –

- Selects V_1 , V_R and V_2 to be sent to using systems, or
- Crew entered V speeds replace calculated speeds
- Display changes to large font; **REF** and caret no longer display.

If the performance data changes:

- FMC replaces existing speeds with FMC calculated speeds in small font
- V speeds are removed from the PFD
- PFD speed tape message **NO V SPD** is shown
- Scratchpad message **TAKEOFF SPEEDS DELETED** is shown.

Note: After an engine is started, the FMC recalculates the takeoff speeds. Any combination of gross weight, OAT, or pressure altitude resulting in a takeoff speed change of two or more knots from the previously calculated speeds, causes the FMC to recalculate takeoff speeds.

⑧ Gross Weight (**GR WT**), Takeoff Gross Weight (**TOGW**)

GR WT shows airplane gross weight from the PERF INIT page.

TOGW - Enter optional airplane takeoff gross weight different from **GR WT** to request new takeoff data using data link.

Valid entry is any weight within the allowable airplane takeoff gross weight range. Flight crew entered value is downlinked when the **REQUEST** prompt is selected.

Entry of a value after takeoff speeds are selected removes the speeds, shows dashes in the speed lines, and shows the scratchpad message **TAKEOFF SPEEDS DELETED**.

Deletion of the **TOGW** value shows **REF SPDS** in small font.

A takeoff uplink shows the uplinked **TOGW** and associated **REF SPDS**.

⑨ Reference Speeds (**REF SPDS**), **ACCEPT**

REF SPDS:

Enables or disables display of the FMC calculated reference (V) speeds in the center column to the left of the V speed lines.

Push toggles together between **ON** and **OFF**.

ON – displays FMC calculated takeoff speeds for comparison with the V speeds in the right column.

OFF – deletes speeds from the center column.

The active state, **ON** or **OFF**, displays in large green font; the inactive state displays in small white font.

ACCEPT:

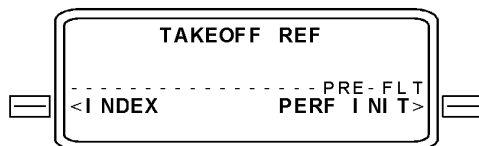
Push – accepts the uplink takeoff data; all pending uplink values are treated as if entered by the flight crew.

⑩ Thrust Limit (**THRUST LIM**)

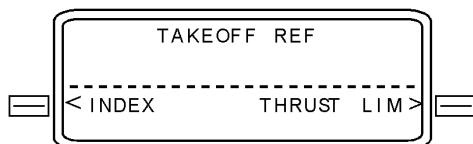
Push - Shows **THRUST LIM** page.

⑪ Reference (**REF**)

Shows the FMC calculated V speeds for comparison with flight crew entered or uplinked values. Display is enabled and inhibited by the **REF SPDS** prompt.

Preflight Status

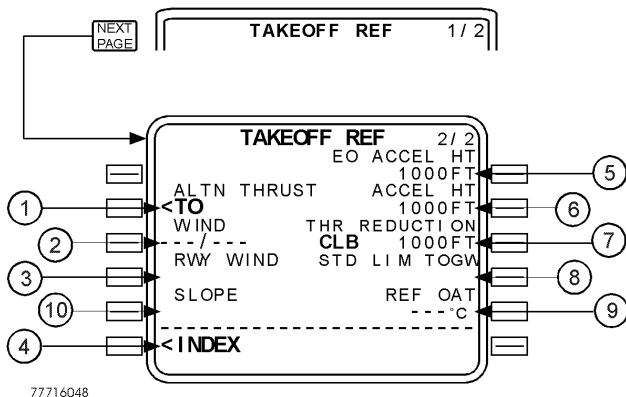
If the required preflight entries are not complete, the words **PRE-FLT** display on the right side of the dashed line. Preflight pages requiring entries display below the dashed line as prompts.



When preflight entries are complete, a dashed line displays below the takeoff reference page data. The **THRUST LIM** prompt displays below the dashed line.

Takeoff Reference Page 2/2

Note: Acceleration/thrust reduction heights are added to runway elevation causing acceleration/thrust reduction at the desired MSL altitude. For example, for a runway elevation of 980 feet, an entry of 2020 acceleration height causes acceleration at 3,000 feet MSL.



① Alternate Thrust (ALTN THRUST) (Not operational on CAL ACFT)

Display is active if a TAKEOFF REF uplink has been accepted which includes alternate thrust data.

Line title may show:

- **ALTN THRUST**
- **ALTN THRUST/FLAPS.**

Data may show temperature and:

- **TO, TO/FLAPS**
- **yy° TO x** (assumed temperature), **yy° TO x/FLAPS.**

Push (with data on the line) - selects the shown alternate thrust or alternate thrust/flaps for takeoff resulting in:

- Recomputation of V speeds
- The line title shows **STD THRUST** or **STD THRUST/FLAPS**
- The **ACCEPT/REJECT** prompt shown on the TAKEOFF REF page 1/2
- New takeoff data is shown
- Shows the EICAS - **FMC** message
- Shows the scratchpad message **TAKEOFF DATA LOADED.**

② WIND

Displays uplinked surface wind direction and speed.

Wind direction and speed can be entered by the flight crew or uplink.

Valid directions are from 0 to 360 degrees. (0 and 360 are shown as 000).

Valid speeds are from 0 to 250 knots.

Subsequent entries may be wind direction or speed only.

Entry of new wind direction or speed results in recomputation of RWY WIND.

Entry or uplink of a value after takeoff speeds are selected deletes V speeds and displays the scratchpad message **TAKEOFF SPEEDS DELETED**.

③ Runway Wind (RWY WIND)

Shows the calculated headwind/tailwind and crosswind components for the takeoff runway and surface wind.

Calculated values are in a small font.

Speed is shown in knots and:

- **H** for headwind
- **T** for tailwind
- **R** for right crosswind
- **L** for left crosswind.

Flight crew entry is limited to headwind/tailwind entry.

Valid flight crew entries are a two digit number followed by **H** or **T**.

Flight crew speed entry without a letter defaults to a headwind component.

A flight crew entry clears the **WIND** line.

④ INDEX

Push - Shows the INIT/REF INDEX page.

⑤ Engine Out Acceleration Height (**EO ACCEL HT**)

Displays acceleration height for flap retraction with an engine out.

Default value is from the airline policy file.

Valid entry is from 400 to 9999 feet.

⑥ Acceleration Height (**ACCEL HT**)

Displays acceleration height for flap retraction.

Default value is from the airline policy file.

Entry is optional. Valid entry is a height from 400 to 9999 feet.

⑦ Climb Thrust Rating and Thrust Reduction (**THR REDUCTION**)

Shows the climb thrust rating selected on the THRUST LIM page and the altitude for reduction from takeoff thrust to climb thrust. Default **THR REDUCTION** is a value from the AIRLINE POLICY file.

Entry

- Is optional for preflight completion.
- May be an altitude or a flap setting.
- Range for altitudes is valid from 400 to 9,999 feet above the origin airport elevation.
- Values are **1** for FLAPS 1 and **5** for FLAPS 5 (entry of **5** when FLAPS 5 is specified as the takeoff flap setting causes the scratchpad to show the message **INVALID ENTRY**).

⑧ Limit Takeoff Gross Weight (**LIM TOGW**)

Shows the uplinked takeoff gross weight limit for the uplinked data.

Manual entry not allowed.

Prefix **ALT** or **STD** is added to line title when alternate or standard takeoff data is pending.

⑨ Reference Outside Air Temperature (REF OAT)

Enter an outside air temperature:

- The FMC recalculates takeoff V speeds.
- After takeoff speeds are selected, deletes the speeds and shows the scratchpad message **TAKEOFF SPEEDS DELETED**.
- For a data link downlink transmission.

Flight crew entered or uplinked data entry.

Valid entries are -54° to 99°C, or -65° to 199°F

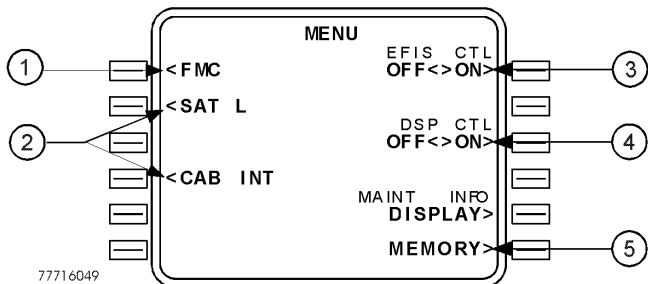
⑩ SLOPE

Flight crew entered or uplinked data entry.

Valid runway slope is **U** for up or **D** for down followed by 0.0 through 2.0 in percent gradient.

Entry of a value after takeoff speeds are selected removes the speeds and shows the scratchpad message **TAKEOFF SPEEDS DELETED**.

Menu Page



- ① **FMC**
Push - Connects FMC to CDU.
- ② **Satellite Communication/Cabin Interphone (SAT/CAB INT)**
See Section 6.5, Communications.
- ③ **EFIS Control (EFIS CTL)**
See Section 6.10, Flight Instruments, Displays.
- ④ **Display Select Panel Control (DSP CTL)**
See Chapter 6.10, Flight Instruments, Displays.
- ⑤ **Memory**
Accessible only on the ground. For maintenance use only.

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FMC TAKEOFF AND CLIMB

Introduction

The FMC takeoff phase starts with the selection of takeoff/go-around (TO/GA). Preparation for this phase starts in the preflight phase and includes entry of the TAKEOFF REF page data.

The takeoff phase automatically changes to the climb phase when the FMC commands climb thrust. The climb phase continues to the top of climb point, where the cruise phase starts.

During takeoff and climb, the specific page listed below is usually used to:

- TAKEOFF REF page - Make last minute changes to thrust derate or V speeds
- DEPARTURES page - Make last minute changes to the departure runway or SID
- CLIMB page - Modify climb parameters and monitor airplane climb performance
- RTE X LEGS page - Modify the route and monitor route progress
- PROGRESS page - Monitor the overall progress of the flight
- THRUST LIM page - Select alternate climb thrust limits
- DEP/ARR INDEX page - Select an approach during a turn-back.

Takeoff Phase

When changes are made to the departure runway and SID, the TAKEOFF REF and DEPARTURES pages must be modified to agree. The modified data are entered the same as during preflight.

With correct takeoff parameters, the FMC commands the selected takeoff thrust when the TO/GA switch is pushed. During the takeoff roll, the autothrottle commands the thrust and the FMC commands acceleration to between V_2+15 and V_2+25 knots, depending on the flap setting.

Usually, VNAV is armed before takeoff. When armed before takeoff, LNAV activates at 50 feet radio altitude and commands roll to fly the active route leg. VNAV activates at 400 feet above runway elevation and commands pitch to fly the climb profile.

Climb

At acceleration height, the first movement of the flap handle during flap retraction, or AFDS capture of MCP altitude lower than acceleration height, VNAV commands acceleration to:

- 250 knots
- $V_{REF} 30 + 80$ knots, whichever is greater.

The VNAV commanded speed is limited by the airplane configuration. At acceleration height, VNAV commands a speed 5 knots below the flap placard speed, based on flap handle position.

At the climb thrust reduction point, the FMC commands a reduction to the selected climb thrust. Passing 10,000 feet, VNAV commands an acceleration to the economy climb speed, which is maintained until entering the cruise phase. Waypoint speed constraints take priority, provided they are greater than $V_{REF} 30 + 80$ or 250 knots.

During the climb, VNAV complies with the LEGS page waypoint altitude and speed constraints. A temporary level-off for a crossing altitude restriction is accomplished at the commanded speed. The commanded speed is magenta.

When the climb speed profile causes an anticipated violation of a waypoint altitude constraint, the FMC shows the CDU scratchpad message **UNABLE NEXT ALTITUDE**. A different speed profile that gives a steeper climb angle must be manually selected.

Altitude Intervention

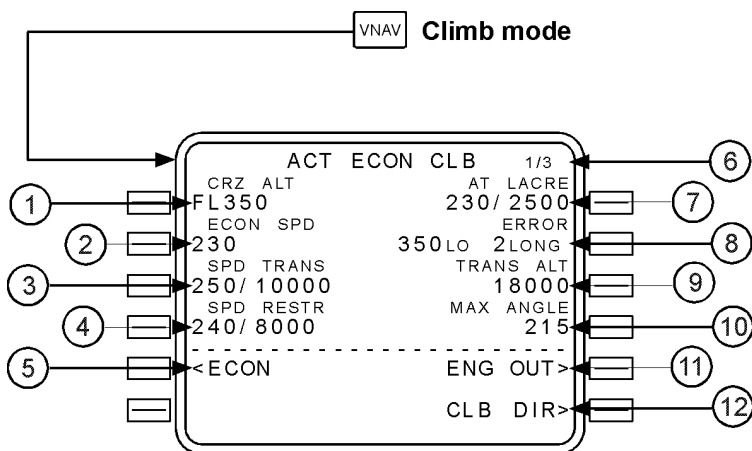
If an unplanned level-off is required, setting the altitude window to the required altitude causes the airplane to level at the set altitude. **VNAV SPD** changes to **VNAV ALT**. The climb can be continued by setting the altitude window to a higher altitude and pushing the altitude selector (**VNAV ALT** changes to **VNAV SPD**). In the climb (**VNAV SPD**), if the altitude window is set to an altitude above other altitude constraints, each altitude constraint can be deleted by each push of the altitude selector. If cruise altitude is set in the altitude window, all waypoint altitude climb constraints to the T/C can be deleted by selection of the **CLB DIR>** prompt on the CLB page.

Climb Page

The climb page is used to evaluate, monitor, and modify the climb path. The data on the climb page comes from preflight entries made on the route and performance pages, and from the airline policy file.

The climb page is the first of the three pages selected with the **VNAV** function key. When the FMC changes to the cruise mode, the climb page data is blanked.

FMC climb can be economy, fixed speed, or engine out.



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① Cruise Altitude (CRZ ALT)

Shows cruise altitude entered on PERF INIT page.

Valid entries are: XXX, XXXX, XXXXX or FLXXX. Altitude displays in feet or flight level depending on transition altitude.

The altitude can be changed by two methods:

- A new cruise altitude can be manually entered from the CDU at any time. The modified cruise altitude is shown in shaded white until executed.
- A new cruise altitude can be entered from the MCP, if intermediate altitude constraints do not exist between the airplane altitude and the MCP altitude. Set cruise altitude in the altitude window and push the altitude selector. The cruise altitude changes without modification or execution.

② Economy Speed (ECON SPD), Selected Speed (SEL SPD)**ECON SPD**

- Speed based on cost index in CAS or Mach
- Used by FMC at altitudes above all waypoint speed constraints, speed restrictions, and speed transition altitudes.

SEL SPD

- Shows when intermediate level off required below an existing speed constraint
- Shows when flight crew enters speed.

Valid entries are CAS or Mach.

The FMC commanded speed is magenta. Usually, CAS speed is magenta and Mach is white. Above CAS/Mach transition altitude, Mach is magenta and CAS is white.

③ Speed Transition (SPD TRANS)

The speed transition line shows the transition speed/altitude from one of these sources:

- The navigation database value for the origin airport
- The value specified from the airline policy file
- A default speed of 250 knots or the airplane performance value of $V_{REF}+80$ knots and 10,000 feet (example 250/10000), if there is no airline policy value.

Magenta when it is FMC command speed.

Not shown after the transition.

Can be deleted.

④ Speed Restriction (SPD RESTR)

Speed restrictions not associated with specific waypoints are manually entered on this line.

Dashes before entry by flight crew.

Valid entry is a CAS and altitude (example 240/8000).

An entry creates a modification. Entry is shaded white until executed; magenta when it is FMC command speed.

⑤ Economy (**ECON**)

Push - Changes climb speed to ECON. Must be executed.

Prompt is shown on line **5L** when the climb mode is not ECON.

⑥ Page Title

The page title shows the type of climb.

- ECON - Speed based on a cost index.
- LIM SPD - Speed based on airplane configuration limiting speed.
- MCP SPD - MCP speed intervention is selected.
- EO - Engine out mode is selected.
- XXXKT - Fixed CAS climb speed profile.
- M.XXX - Fixed Mach climb speed profile.
- ACT - Prefix shown when climb phase is active.

Reasons for fixed climb speeds are:

- Takeoff/climb acceleration segment constraints.
- Waypoint speed constraints.
- An altitude constraint associated with a speed constraint.
- A speed transition.
- A flight crew entered selected speed (SEL SPD).

⑦ Waypoint Constraint (**AT XXXXX**)

Shows airspeed and/or altitude constraint at waypoint XXXXX.

Can also display **HOLD AT XXXXX** followed by a speed/altitude constraint.

FMC commands the slower of constraint speed or performance speed.

Constraints are entered on RTE LEGS page.

Delete here or on RTE LEGS page.

Blank if no constraint exists.

Magenta when it is FMC command speed or altitude.

⑧ ERROR at Waypoint

Displays altitude discrepancy and distance past waypoint where altitude will be reached.

Blank if no error exists.

⑨ Transition Altitude (TRANS ALT)

Transition altitude for origin airport contained in navigation database. FMC uses 18000 feet if transition altitude is not available.

Manually change transition altitude here or on DESCENT FORECAST page.

Valid entries are **xxx**, **xxxx**, **xxxxx**, or **FLxxx**.

CDU altitude data change from altitudes to flight levels above the transition altitude.

⑩ Maximum Angle (MAX ANGLE)

Maximum angle of climb speed.

Entry not allowed.

⑪ Engine Out (ENG OUT)

Push - Modifies page to show engine out (**ENG OUT**) performance data.

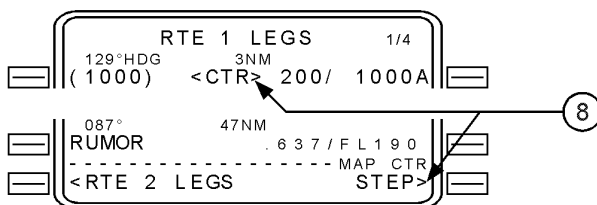
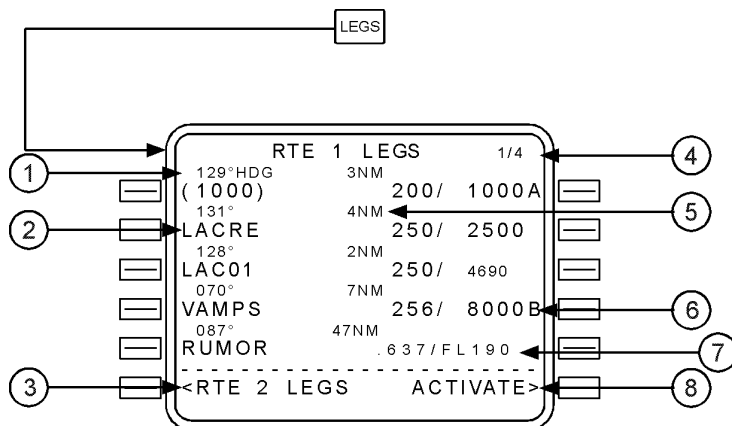
Shaded white until the modification is executed.

⑫ Climb Direct (CLB DIR)

Displays when climb altitude constraint exists between current altitude and FMC cruise altitude.

Push – deletes all waypoint altitude constraints between the airplane altitude and the MCP altitude or FMC cruise altitude, whichever is lower. FMC cruise altitude is not affected.

RTE X LEGS Page



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Leg Direction

Leg segment data in line title:

- Courses - Magnetic (xxx°) or true (xxx° T)
- Arcs - Distance in miles, ARC, turn direction (example: 24 ARC L)
- Heading leg segments - xxx° HDG
- Track leg segments - xxx° TRK
- Special procedural instructions from database – **HOLD AT**, **PROC TURN** or **PROC HOLD** (FMC exits **HOLD** when crossing the fix after entry).

Calculated great circle route leg directions may be different than chart values.

Dashes display for an undefined course.

② Waypoint Identifier

Active leg is always the first line of the first active RTE X LEGS page.

Active waypoint is on active leg and is magenta. Modified waypoints are shaded white until executed.

All route waypoints are shown. Waypoints on an airway are included on the route legs page. Waypoints are shown in flight sequence.

Waypoints can be modified. Examples:

- Add waypoints
- Change waypoint sequence
- Delete waypoints
- Connect route discontinuities.

Shows the waypoint by name or condition.

Boxes are shown for route discontinuities.

Dashes are in the line after the end of the route.

③ Route 2 Legs (**RTE 2 LEGS**)

Push -

- Shows the RTE 2 LEGS
- When RTE 2 LEGS page is shown, prompt changes to **RTE 1 LEGS**.

④ Page Title

Title format shows route status:

- **RTE X LEGS** (cyan) - Inactive route
- **ACT RTE X LEGS** (white) - Active route
- **MOD** (shaded white) **RTE X LEGS** (white) - Modified active route.

⑤ Distance to Waypoint

Distance (decreasing) from airplane to active waypoint or from waypoint to waypoint. Blank for some leg types (e.g. HDG or VECTORS).

⑥ Waypoint Speed/Altitude Constraints

Waypoint speed or altitude constraint in large font.

Manual entry allowed in climb or descent phase. Entered by FMC when constraints are part of a procedure.

Magenta when it is an FMC commanded speed/altitude. Airspeed constraint may be magenta in one line with magenta altitude in another line.

Speed constraint is assumed to be at or below the shown speed.

Data entry:

- Speed entry can be airspeed or Mach
- Altitude entry can be thousands of feet or flight level (19000, FL190)
- XXX/XXXXX - Airspeed/altitude entered simultaneously
- XXX, XXXX, XXXXX or /XXX, /XXXX, /XXXXX – Altitude only.
- Enter FL 190 or 19,000 feet as 190 or 19000. Enter FL090 or 9,000 feet as 090 or 9000. Enter 900 feet as 009 or 0900. Enter 90 feet as 0090.

Altitude constraint suffixes:

- Blank - Cross at altitude
- **A** - Cross at or above altitude
- **B** - Cross at or below altitude
- Both - Altitude block. If constraint is to cross between two altitudes when climbing, enter lower altitude followed by “**A**”; then, enter higher altitude followed by “**B**”. Example: 220A240B. Reverse order for descent.
- **s** - Planned step climb (refer to Flight Management, Navigation, Cruise).

⑦ Waypoint Speed/Altitude Predictions

Waypoint speed and altitude predictions in small font.

Dashes display in predicted descent region prior to descent path calculation. Descent path calculation requires an altitude constraint below cruise altitude.

Manual entry allowed in climb or descent phase.

⑧ **ACTIVATE, Route (RTE) DATA**

Push - Three possible prompts

- **ACTIVATE** - Activates inactive flight plan; shows **RTE DATA** prompt
- **RTE DATA** (route data) - Shows route data page
- **MAP CTR STEP** (map center step) - Changes centered waypoint on ND.
<CTR> is adjacent centered waypoint on the RTE LEGS page.

ACTIVATE prompt shown when RTE and RTE LEGS flight plan is inactive.

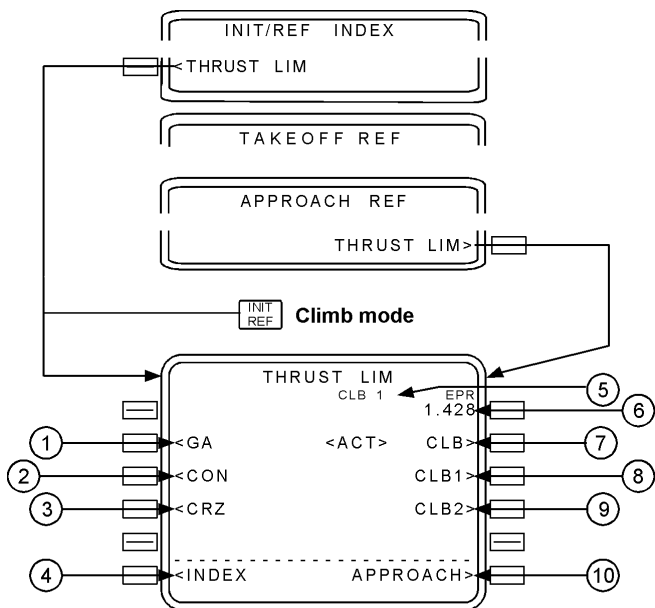
RTE DATA shown after **ACTIVATE** prompt is pushed.

MAP CTR STEP prompt shown when the EFIS control panel ND mode selector is in PLAN position.

Thrust Limit Page

Thrust limits are selected on the thrust limit page. After airborne, this display replaces the takeoff thrust limits with applicable thrust limits for climb. The selected limits are shown here and on the EICAS Display.

Fixed thrust derates can be selected for climb. Go-around, continuous and cruise thrust limits are available also.



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① Go-Around (GA)

Push - Selects Go-Around thrust limit mode.

② Continuous (CON)

Push - Selects maximum continuous thrust limit. Selection is usually used for critical situations, such as engine out.

③ Cruise (CRZ)

Push - Selects cruise thrust limit mode.

④ INDEX

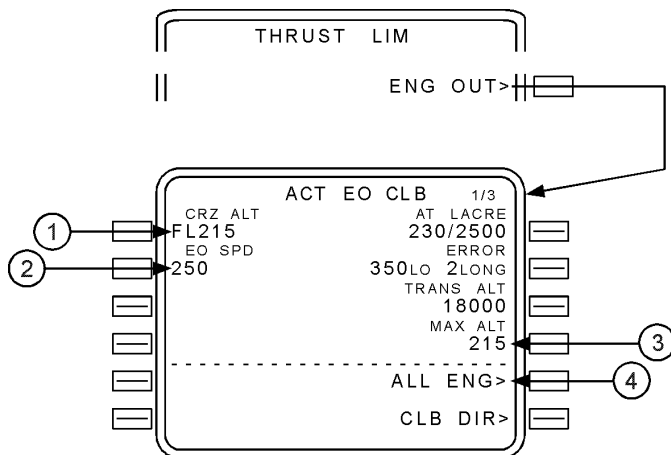
Push - Shows INIT/REF INDEX page.

- ⑤ Thrust Reference Mode
Active thrust limit mode.
- ⑥ N_1
Commanded thrust setting.
- ⑦ Climb (CLB)
Push - Selects full rated climb thrust.
- ⑧ Climb 1 (CLB 1)
Push - Selects CLB 1 derated climb thrust.
- ⑨ Climb 2 (CLB 2)
Push - Selects CLB 2 derated climb thrust.
- ⑩ **APPROACH**
Push - Shows APPROACH REF page.

Engine Out Climb

Engine out (EO) VNAV climb guidance is available on the EO CLB page. The EO CLB page must be selected and executed by the flight crew. Engine out data is available with both engines operating. The engine out climb phase automatically changes to the engine out cruise phase when reaching the cruise altitude.

EO CLB Page



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The modified page shows engine out performance limitations. Manual entries are allowed. After execution, VNAV gives EO guidance in the climb.

① Cruise Altitude (**CRZ ALT**)

Shows cruise altitude if less than MAX ALT,

Shows **MAX ALT** if less than cruise altitude.

Manual entry is allowed.

② Engine Out Speed (**EO SPD**)

Shows engine out climb speed.

Valid entry is xxx for CAS.

Valid entry is o.xxx for Mach. Trailing zeros can be omitted.

A manual entry may cause MAX ALT to change.

③ Maximum Altitude (**MAX ALT**)

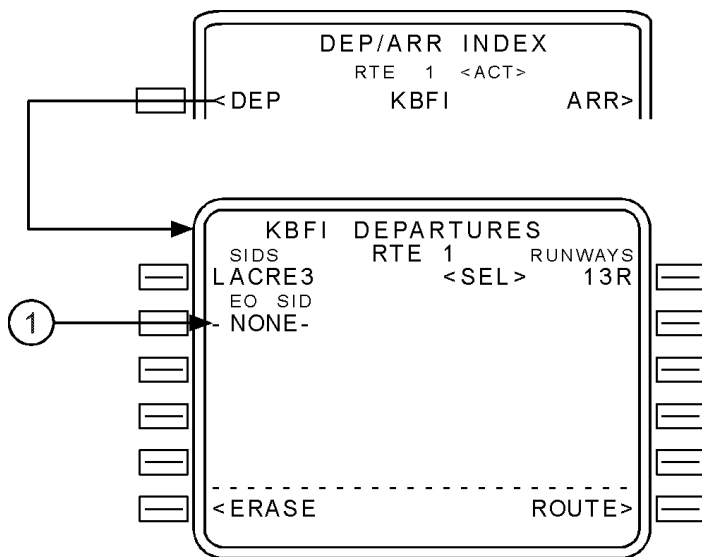
Lower of maximum altitude at engine out climb speed or cruise speed.

Entry not allowed.

④ **ALL ENG**

Push - Modifies page to show all engine (**ALL ENG**) performance data.

Engine Out Departure



77716054

① Engine Out Standard Instrument Departure (EO SID)

Engine out SIDs can be created by the airline for specific runways.

The FMC puts the EO SID into the route as a modification if:

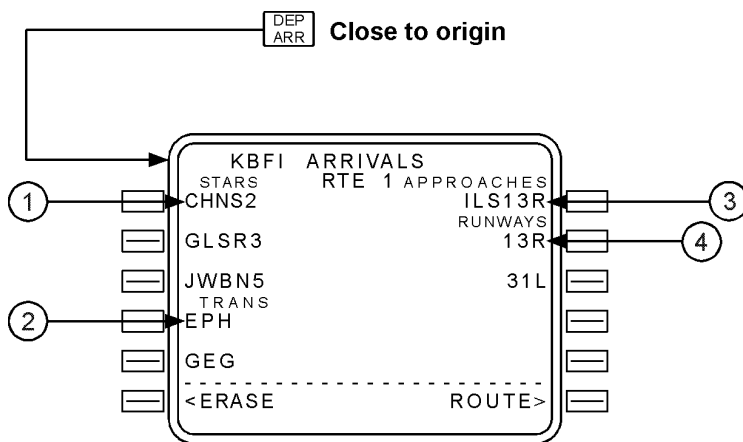
- An engine failure is sensed
- Flaps extended
- And the navigation database has an EO SID for the departure runway.

The modification can be executed or erased.

Air Turnback Arrivals Page

During a turnback situation, the flight crew requires quick access to the arrivals data for the origin airport. The ARRIVALS page allows access without changing the destination on the route page.

During climb, less than 400 miles from the origin, and while nearer to the origin than the destination, push the DEP ARR function key to show the ARRIVALS page for the origin airport.



77716055

① STARS

Shows STARS for origin airport.

② TRANS

Shows transitions for origin airport.

③ APPROACHES

Shows approaches for origin airport.

④ RUNWAYS

Shows runways for origin airport.

FMC CRUISE

Introduction

The cruise phase automatically starts at the top of climb.

During cruise, the primary FMC pages are:

- RTE X LEGS
- PROGRESS
- CRZ.

The RTE LEGS pages are used to modify the route. The PROGRESS pages show flight progress data. The CRZ pages show VNAV related data. Other pages are:

- POS REF page - Verifies the FMC position
- RTE DATA page - Contains progress data for each waypoint on the RTE LEGS page
- WINDS page - Enter forecast wind and temperature
- REF NAV DATA page - Contains data about waypoints, nav aids, airports, or runways, and can be used to inhibit nav aids
- RTE X page - Use to select a route offset
- FIX INFO page - Contains data about waypoints. Page data can be transferred to other pages to create new waypoints and fixes
- SELECT DESIRED WAYPOINT page - Shows a list of duplicate waypoints from the navigation database. The flight crew selects the correct waypoint from the list
- POS REPORT page - Contains data for a position report.

The CLB page automatically changes to CRZ at the top of climb. The CRZ CLB and CRZ DES pages automatically change to CRZ at the new cruise altitude. The CRZ page automatically changes to DES at top of descent.

LNAV Modifications

This section shows typical techniques to modify the route. The modifications include:

- Add and delete waypoints
- Change waypoint's sequence
- Connect discontinuities
- Intercept a course.

RTE LEGS Page Modifications

When modifications are made to a RTE LEGS page, several automatic prompt or identifying features help the flight crew manage the modifications, such as:

- **ERASE**
- **INTC CRS TO**
- **INTC CRS FROM.**

Modified entries are shown in shaded white.

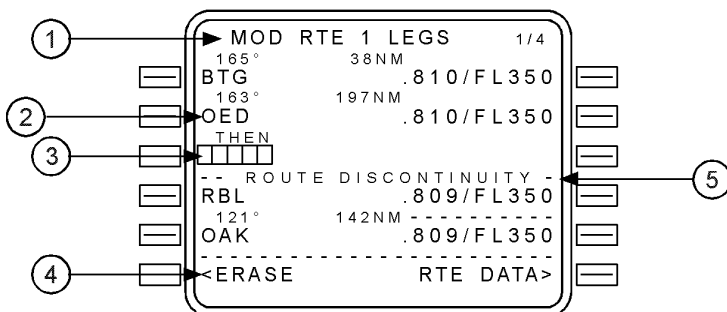
Add a Waypoint

A waypoint can be added to the route at any point. Waypoints added to the flight plan make route discontinuities.

First, the waypoint name is entered into the CDU scratchpad.

Second, find the correct line in the flight plan and push the adjacent line select key. The scratchpad waypoint name is put into the selected line. The entered waypoint is connected to the waypoint above it via a direct route. A route discontinuity follows the waypoint.

For example, **OED** is typed into the scratchpad. Push line select key 2L to put **OED** into line 2. The FMC assumes BTG direct OED. RBL and the rest of the flight plan follow the route discontinuity.



77716056

① Page Title

MOD (shaded white) - Replaces **ACT** when modification is in progress.

ACT (white) - Replaces **MOD** when **ERASE** is selected or execute key is pushed.

② Modified Waypoint

Waypoint name is shaded white until executed.

OED waypoint entered into the route after **BTG**. Modification creates route discontinuity because **OED** was not in active route.

③ Discontinuity Waypoint

Discontinuity is corrected when applicable waypoint is entered into boxes.

④ **ERASE**

Push - Removes all modifications and shows active data.

Shown when the FMC contains modified data.

Removed when selected or the modifications are executed.

⑤ **ROUTE DISCONTINUITY**

Line title separates route segments when there is a discontinuity.

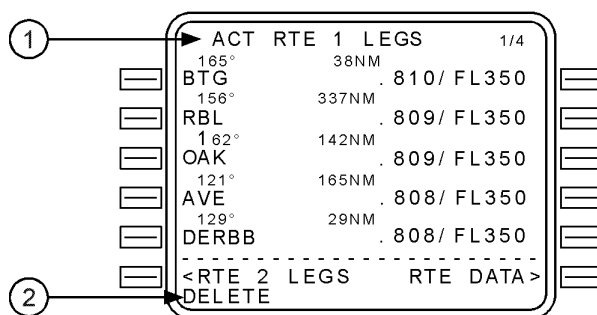
Note: Performance predictions to destination on the **PROGRESS** page are calculated assuming the route of flight is direct between waypoints on either side of a route discontinuity.

Delete Waypoints

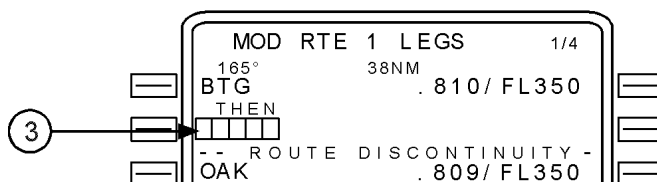
Use the RTE LEGS page to remove waypoints from the route. The active waypoint and conditional waypoints can not be deleted. Two methods to remove a waypoint are:

- Delete the waypoint with the DELETE function key
- Change the waypoints sequence.

The data in the route before the deleted waypoint does not change. A discontinuity is put in the route when the DELETE function key used to remove a waypoint.



77716057



77716058

① Active Route

The active route shows **RBL** followed by **OAK** and **AVE**.

② DELETE Entry

Pushing the DEL function key arms the delete function and selects **DELETE** to the scratchpad.

③ Route Discontinuity

With **DELETE** in the scratchpad, pushing the line select key for **RBL** deletes the waypoint. Boxes replace **RBL** and a route discontinuity displays.

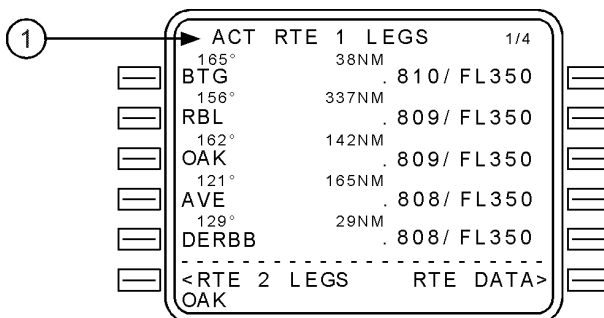
Waypoint Sequence

Change Waypoint Sequence

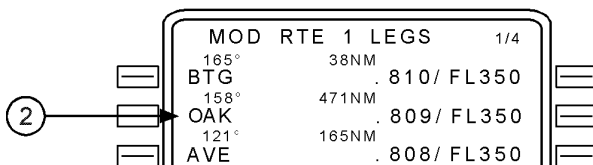
Waypoints moved from one position in the flight plan to another do not cause route discontinuities.

The waypoint may be manually typed or copied from the flight plan. To copy a waypoint from the flight plan, find the applicable waypoint on one of the RTE LEGS pages. Push the line select key adjacent the waypoint.

The example below shows the flight plan modified to go **BTG** direct **OAK**. Push the line select key adjacent to **OAK** to put **OAK** into the scratchpad. Push the line select key adjacent to **RBL**. **RBL** is removed from the flight plan and the routing is direct from **BTG** to **OAK** to **AVE**. The modification does not cause a route discontinuity. Several waypoints can be removed from the flight plan at a time with this method.



77716059



77716060

① Active Route

The active route shows **RBL** followed by **OAK** and **AVE**. The clearance is to fly from **BTG** direct **OAK**. The **OAK** waypoint is copied into the scratchpad.

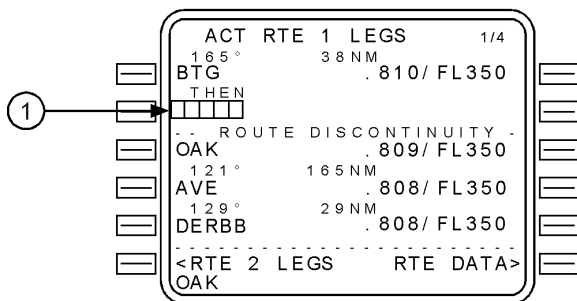
② Change **OAK**s Sequence

OAK is transferred to the waypoint after **BTG**. **RBL** is removed and the route stays continuous.

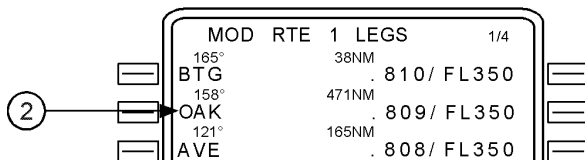
Remove Discontinuities

A discontinuity exists when two waypoints are not connected by a route segment. Connect a route segment after the discontinuity to the route segment before the discontinuity to remove the discontinuity.

Copy the subsequent waypoint from the route into the scratchpad and enter it into the discontinuity, just as when adding a waypoint.



77716059a



77716060a

① Route Discontinuity

The active route has a discontinuity after BTG. The example shows how to fly direct from BTG to OAK. Copy OAK to the scratchpad. Any waypoint in the route can be copied into the scratchpad to remove the discontinuity.

② Continuous Route

OAK is put into the boxes to remove the discontinuity.

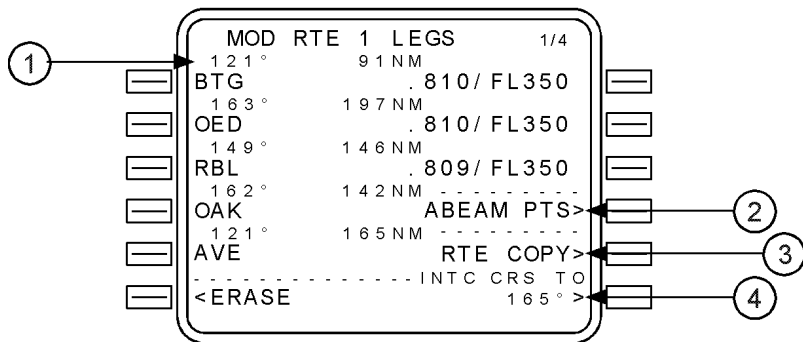
Entering a waypoint which does not already exist on the route moves the discontinuity one waypoint further down the route.

Direct To And Intercept Course To

If the airplane passes the last active route waypoint (or offset) or the last waypoint prior to a route discontinuity, LNAV maintains the current heading and a scratchpad message displays. If LNAV is not active, activation can be accomplished in the following three ways:

- When the airplane is within 2.5 miles of the active leg and on an intercept heading to the active leg, pushing the LNAV switch activates the LNAV. The airplane turns to intercept the active leg. If the intercept angle is large, the airplane may overshoot the active leg.
- When more than 2.5 miles from the active leg, pushing the LNAV switch when the airplane is on an intercept heading to the active leg arms LNAV. Activation occurs as necessary to intercept the active leg with no overshoot. The intercept heading must intersect the active leg inbound before the active waypoint.
- Fly direct to a waypoint or intercept a course to a waypoint. Enter a waypoint in the RTE LEGS page active waypoint line to fly direct. Use the **INTC CRS TO** prompt in line 6R to create an intercept course to the waypoint. Pushing the LNAV switch arms or activates LNAV, depending on the distance to the active leg.

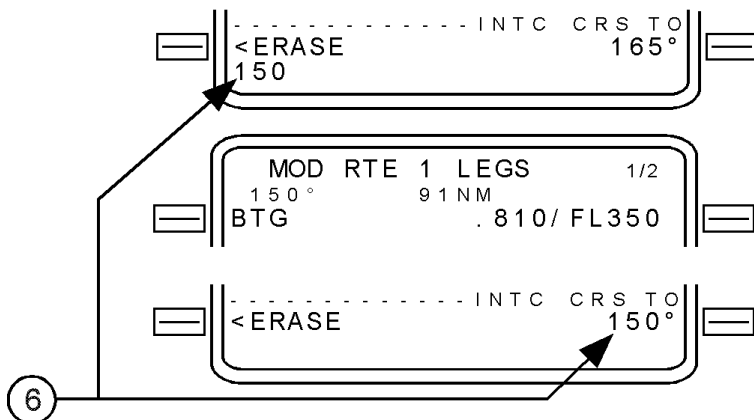
The example below depicts the airplane being off course to the right, followed by a modification to fly direct to **BTG**.



77716061



77716062



77716063

① Leg Direction

Direct course from airplane present position to entered waypoint.

Execute to proceed direct to active waypoint.

② Abeam Points (ABEAM PTS**)**

Push -

- Creates place bearing distance waypoint on the Direct To leg abeam the bypassed waypoint if the bypassed waypoint was a database airport, navaid, NDB, or waypoint.
- Creates latitude/longitude waypoint on the Direct To leg abeam the bypassed waypoint if the bypassed waypoint was a latitude/longitude waypoint.
- Creates a new place bearing distance waypoint based on the original “place” on the Direct To leg abeam the bypassed waypoint if the bypassed waypoint was a place bearing distance waypoint.
- Creates a new latitude/longitude reporting point on the Direct To leg based on the entered latitude or longitude reporting point.
- Line title displays **ABEAM PTS** and line data displays **SELECTED**.
- Altitude/speed constraints for bypassed waypoints are removed.

ABEAM PTS prompt displays whenever the active waypoint name is modified, usually for direct-to routing.

③ Route Copy (RTE COPY**)**

Push -

- Copies the active route into the inactive route.
- Erases previous inactive route.
- Line title displays **RTE COPY** and line data displays **COMPLETE**.
- Subsequent route modifications remove **RTE COPY** prompt.

④ Intercept Course TO (**INTC CRS TO**) - Select

Displays whenever the active waypoint name is modified.

Displays boxes if entered waypoint not in the active route.

Displays current route course and prompt caret if entered waypoint in the active route.

When boxes displayed, valid entry is intercept course from 000 through 360. May be changed until executed. Entered or selected value displays in large font.

Push –

- When current route course (165°) displayed, selects it as intercept course to active waypoint.
- Displays entry or current route course to active waypoint.
- Removes **ABEAM PTS** and **RTE COPY** prompts.

⑤ Intercept Course

After pushing **INTC CRS TO** and prior to execution, displays direct – to inbound course at the waypoint; changed by entry in intercept course to (**INTC CRS TO**) line or by selecting intercept course to. After execution, displays current required track to fly inbound course to the waypoint.

⑥ Intercept Course TO (**INTC CRS TO**)

To change intercept course:

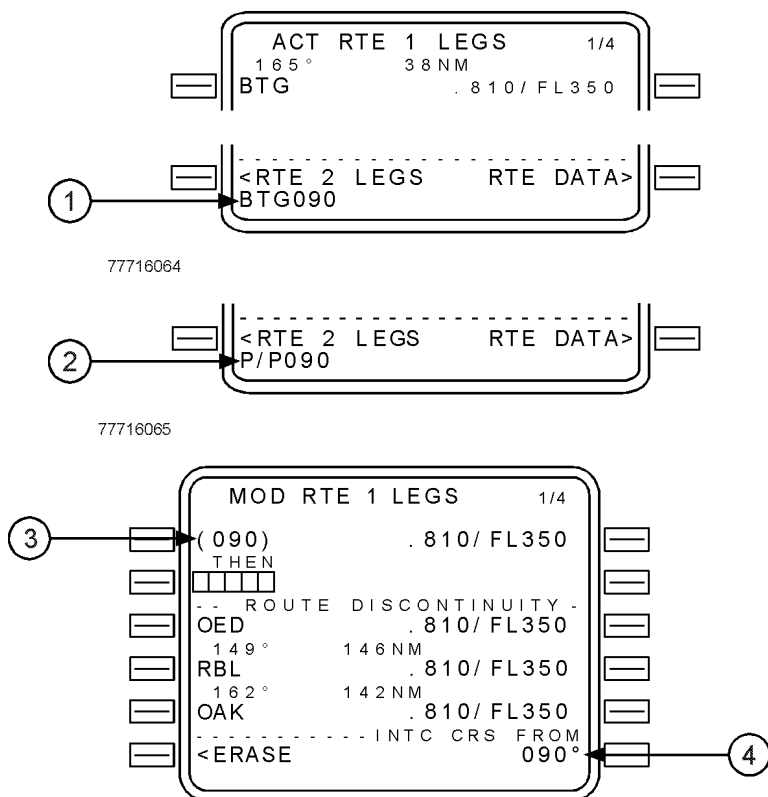
- Enter the inbound intercept course (150°) in the scratchpad.
- Select the **INTC CRS TO** line to change the leg direction; intercept course to BTG of 150° is entered in the **INTC CRS TO** line and above the active waypoint.

Intercept Course From

The steps to create an intercept course from a waypoint are nearly the same as the steps for an intercept course to. The waypoint name in the scratchpad is suffixed with the outbound course.

An intercept course can be created outbound from a waypoint in the navigation database or from present position. The waypoint does not have to be in the route. Entering a waypoint and course pair into the active waypoint line shows the **INTC CRS FROM** prompt. The FMC calculates a route leg with the waypoint as the origin of the entered course.

The example shows a 090° course from BTG, entered as BTG090. When this course intercept is put into the active waypoint line, the course (090°) is shown in the leg direction and the waypoint is shown as a conditional waypoint consisting of a course intercept (090°).



① Waypoint and Outbound Course

Enter the waypoint name and outbound course into scratchpad.

② Present Position and Outbound Course

Enter P/P and outbound course into scratchpad.

③ Active Outbound Course Entry

After active waypoint line is selected, the outbound course is shown. The waypoint name is not used.

For example, BTG090 is entered into the active waypoint line. The FMC calculates a new route leg with BTG as the origin on an outbound course of 090°.

④ Intercept Course From (**INTC CRS FROM**)

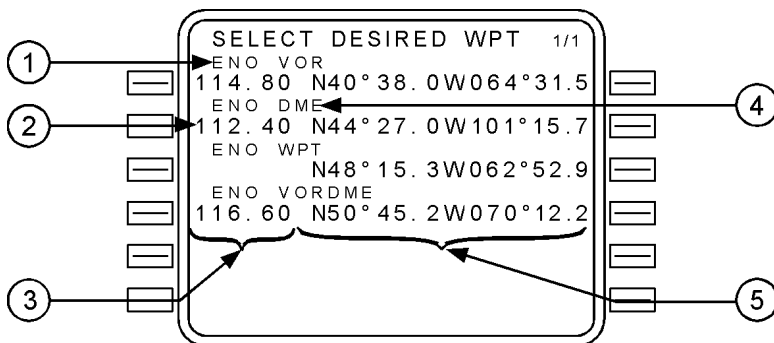
Shows outbound course from entered waypoint.

Shows the active waypoint name is modified with P/P or waypoint outbound entry.

Valid input is any course from 000 through 360. May be changed until executed.

Select Desired Waypoint Page

When a waypoint identifier is not unique (other database waypoints have the same name), a selection of which geographical location to use must be made before the waypoint can be used in the route. The SELECT DESIRED WPT page is automatically shown when the FMC encounters more than one location for the same waypoint name after a waypoint entry.



77716069

① Identifier

Shows the identifiers for the duplicate named waypoints. Select the correct waypoint by pushing the applicable left or right line select key.

② Waypoint Lines

Display a sorted list of waypoints with identifier, navaid type, frequency, and coordinates:

- When page is accessed as a result of a flight plan modification, sort is based on proximity to the waypoint preceding the entered waypoint.
- When page is accessed as a result of a DIR/INTC or REF NAV DATA entry, sort is based on proximity to current aircraft position.

Push – Selects waypoint location for use; returns display to page previously in use.

Pushing any CDU function key exits page without selecting a waypoint.

③ Frequency

Shows the frequency of the navaid.

Blank if the waypoint is not a navaid.

④ Type

Shows the type of navaid.

Blank if the waypoint is not a navaid.

⑤ Latitude/Longitude

The latitude/longitude is shown for each duplicate name.

Airway Intercept

Just as in intercept to/from, LNAV can be used to intercept an airway. An airway intercept changes the active waypoint on the RTE and LEGS pages.

Enter the airway identifier under VIA on line 1 of the RTE page. Boxes display under TO. Enter the desired airway exit waypoint in the boxes. For this open-ended airway intercept, the FMC selects the waypoint preceding the closest abeam location as the starting waypoint of the airway. This waypoint displays on line 1. The entered airway and the desired exit point display on line 2. Executing the modification makes the leg to the FMC selected airway start waypoint the active leg segment.

If the clearance heading intercepts the active leg segment, LNAV can be armed and the intercept will occur. In most airway intercept situations, the commanded heading will not intercept the active leg.

If the clearance heading does not intercept the active leg segment, use the intercept-course-to procedure to make the course inbound to the waypoint (after the crossing location) the active leg segment.

Example:

The active route is direct to EPH, then direct to MWH. ATC clears the airplane to:

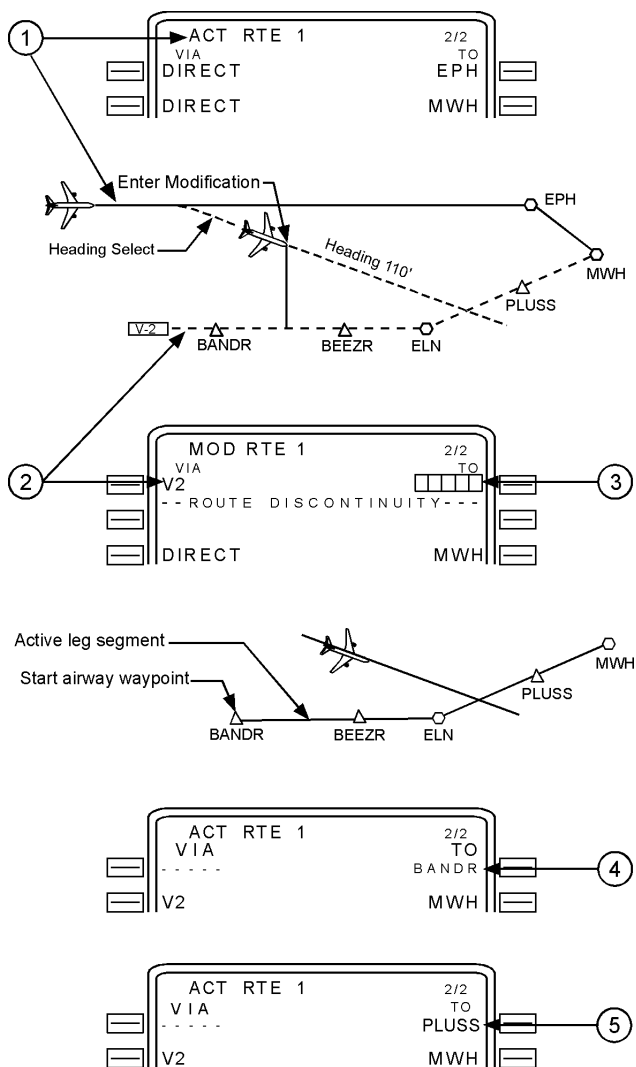
- Turn right heading 110°
- Intercept V2
- Proceed via V2 to MWH.

Adding the V2 modification to MWH shows this LEGS page waypoint sequence:

- BANDR
- BEEZR
- ELN
- PLUSS
- MWH.

Modify the LEGS page using a course intercept to the waypoint after the crossing location. In this case, it would be PLUSS. PLUSS becomes the active waypoint on the V2 airway. The LEGS page now displays:

- PLUSS
- MWH



77716070

① Active RTE 1 Page

The route page before the ATC clearance.

② Input Airway

Enter the airway in the first VIA position on the RTE page. Boxes are shown in the TO position and then a route discontinuity.

③ Airway Exit

Enter airway exit point into the boxes.

④ Start Airway Waypoint

The FMC selects BANDR as the start airway waypoint.

After entering MWH in the boxes:

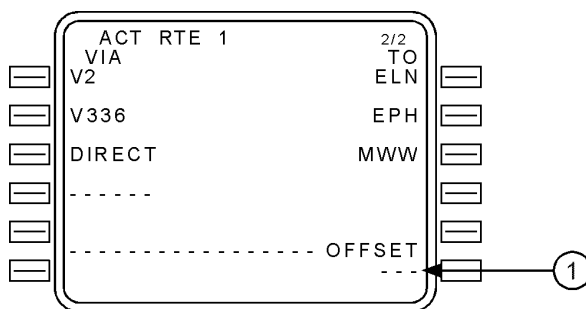
- The airway line moves down one line
- The start airway waypoint is shown in the first line TO position. The FMC selects BANDR as the start airway waypoint
- Dashes are shown in the VIA to the start airway waypoint.

⑤ New Active Waypoint

Following modification and execution of the course intercept procedure to PLUSS, the LEGS page displays PLUSS as the active waypoint.

LNAV can be armed and the airway intercept can be completed.

When on the route offset, active route waypoints sequence normally. However, during transition to or from an offset route greater than 21 NM, the crosstrack limit is extended to 200 NM.



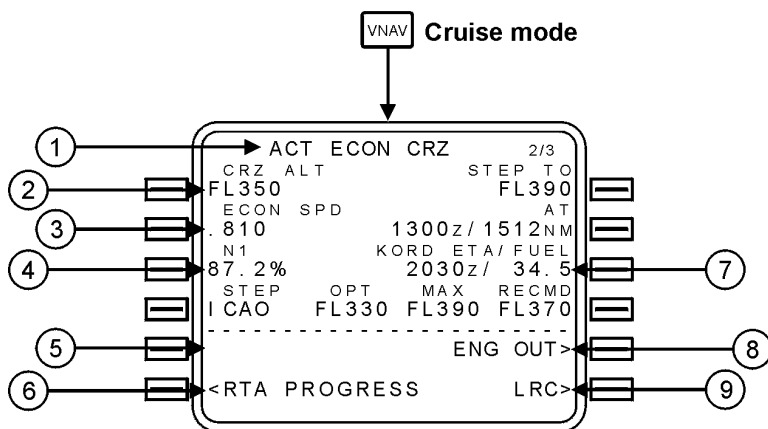
77716071

An offset propagates along the route to a Standard Terminal Arrival Route (STAR), approach or approach transition, discontinuity, end of route, track change greater than 135°, or holding pattern. An offset can be removed by deleting the offset, entering an offset value of zero, or proceeding direct to a waypoint.

CRUISE PAGE**All Engine Cruise**

The cruise page is used to monitor and change cruise altitude and speed. Speed changes can be manually selected or automatically selected with the selection of other VNAV modes. Cruise climbs, cruise descents, and step climbs can be accomplished from the cruise page.

When using VNAV in economy mode, page data is based on operating at ECON SPD. Economy cruise speed is based on cost index. When the flight crew enters a selected speed, page data changes. When the FMC is in the engine out mode, the data reflects airplane capabilities with one engine inoperative. The long range cruise (LRC) mode calculates speeds to maximize airplane range.



77716072

① Page Title

The page title shows the active or modified type of cruise. Usually, the title contains ECON for the economy cruise mode. Fixed speed, engine out, and long range cruise modify the title.

Page titles include:

- CO - Engine out mode and **co** speed selected
- CRZ CLB or CRZ DES - Cruise climb or descent
- ECON - Speed is based on a cost index
- EO - Engine out mode is selected

- EO LRC D/D - Long range cruise drift down, is shown when EO is selected and the airplane altitude is above the maximum altitude for engine out performance
- LIM SPD - Mode is based on an airplane configuration limiting speed
- LRC - Long range cruise mode
- MCP SPD - Speed intervention is applied from the MCP
- M.XXX - Selected Mach cruise speed
- XXXKT - Selected CAS cruise speed.

② Cruise Altitude (**CRZ ALT**)

Displays cruise altitude entered on PERF INIT page.

Valid entries are: XXX, XXXX, XXXXX, or FLXXX. Altitude displays in feet or flight level depending on the transition altitude.

Modified values display in shaded white.

A new entry changes the page title to CRZ CLB or CRZ DES.

Changing the MCP altitude and pushing the altitude selector enters the MCP altitude as the active cruise altitude, without creating a modification.

③ Economy Speed (**ECON SPD**), Selected Speed (**SEL SPD**)

Shows the target speed or Mach in magenta.

MOD is shown in the page title in shaded white until the modification is erased or executed.

SEL SPD displays when flight crew enters speed.

LRC or company (**CO SPD**) display when selected, depending on the VNAV mode.

④ N_1

Shows the N_1 necessary for level flight at the target airspeed.

⑤ Economy and Required Time of Arrival RTA/Economy (**ECON**, **RTA/ECON**)
ECON

- Push - Selects VNAV ECON mode.
- Shown when an RTA waypoint is not in the flight plan and VNAV is not in the economy mode.

RTA/ECON

- Push - Selects RTA speed mode. Shows **ECON** prompt.
- Shown when an RTA waypoint is in the flight plan and VNAV is not in the RTA mode.

⑥ Required Time of Arrival (**RTA**) **PROGRESS**

Push - Shows RTA PROGRESS 3/3.

⑦ Destination **ETA/FUEL**

Estimated time of arrival and calculated fuel remaining at the destination.

Shows the same data for the alternate airport when a **DIVERT NOW** modification is selected from the **ALTN** page.

Calculations are based on optimum step climbs and cruise altitudes.

⑧ Engine Out (**ENG OUT**)

Push –

- Displays engine out cruise page
- Commands engine out performance calculations
- Changes CRZ ALT if above maximum engine out altitude
- Changes target speed to engine out LRC speed
- Upon execution, thrust reference mode changes to **CON**.

⑨ Long Range Cruise (**LRC**)

Push - Shows the long-range cruise page.

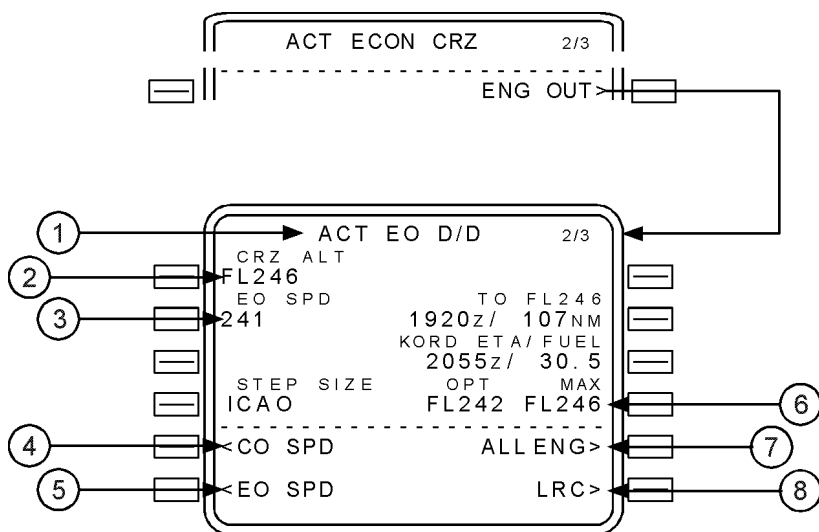
Engine Out Cruise

Engine out VNAV cruise guidance is available on the CRZ page. Engine out data is also available with both engines operating.

The initial page data includes engine out performance limitations. Manual entries are allowed. When above the maximum engine out cruise altitude, VNAV calculates engine out (EO) guidance for drift down (D/D) if necessary. The EO D/D page automatically changes to the EO CRZ page when reaching the engine out cruise altitude. Subsequent engine out cruise climb or descent is accomplished the same as two engine cruise climb or descent.

As the environmental conditions change and the airplane gross weight decreases, maximum altitude may increase. A cruise climb may be possible under these conditions.

The example is based on a cruise altitude above the maximum engine out altitude. When **ENG OUT** is first selected, the default values are used.



① Page Title

Displays **EO D/D** (for this example, airplane is above MAX altitude).

Displays **MCP SPD D/D** when controlling to a manually entered speed during the driftdown.

Displays **EO LRC** (long range cruise) **D/D** when LRC selected during driftdown.

Displays **EO LRC** when in level cruise flight and the LRC speed is selected.

Displays **EO CRZ CLB** or **EO CRZ DES** during engine out cruise climbs or descents and the airplane is below the engine out maximum altitude.

② Cruise Altitude (**CRZ ALT**)

Displays altitude from MAX ALT line when current CRZ ALT above MAX ALT.

Manual entry of an altitude above maximum engine out altitude results in the scratchpad message, "**MAX ALT FLXXX.**"

Valid entries are the same as all engine cruise page.

③ Engine Out Speed (**EO SPD**)

Shows the target speed or Mach in magenta.

Manual entry is allowed.

Valid entries are the same as all engine cruise page.

A manually entered speed changes the line title to SEL SPD.

ECON can be replaced with long range cruise (**LRC**), company (**CO SPD**), or engine out (**EO SPD**) speed using prompts at the bottom of the page.

Selecting any other speed shows engine out (**EO SPD**) as a speed select prompt.

Manual entries may change MAX altitude.

④ Company Speed (**CO SPD**)

Push - Modifies the page with company speed, engine out data from the Airline Policy page.

⑤ Engine Out (**EO SPD**)

Push - Enables execution of engine out minimum drag speed profile.

Shown when **EO LRC**, **EO SEL SPD**, or **CO SPD** is the active speed mode.

⑥ Optimum Altitude and Maximum Altitude (**OPT**, **MAX**)

OPT – Displays the optimum altitude based on airplane gross weight and speed displayed on the speed line.

MAX - Displays the maximum cruise altitude based on:

- Current gross weight
- Engine out operation
- Selected speed option
- Disregarding any altitude or speed constraints, and
- Residual climb rate of a 300 feet per minute.

⑦ ALL Engine (**ENG**)

Push - Shows a MOD XXX CRZ page with performance based on both engines operating.

Selection and execution allows subsequent selection of two engine economy VNAV modes.

⑧ Long Range Cruise (**LRC**)

Push - Enables execution of engine out long range cruise.

Display when **EO** or **SEL SPD** is the active mode.

INTENTIONALLY LEFT BLANK

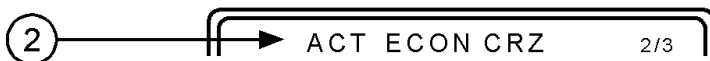
VNAV Modifications

During the cruise phase, two types of climbs can be managed by VNAV: cruise and step climbs. Cruise climbs are entered by the flight crew. Planned step climbs can be entered by the flight crew. Optimum step climbs are calculated by the FMC. In all cases, the new climb altitude must be entered into the MCP altitude window before VNAV commands the climb.

Cruise Climb

Setting an altitude above the current cruise altitude in the MCP altitude window and pushing the altitude selector causes the altitude to be set to the MCP altitude and the airplane to climb to the new cruise altitude. The reference thrust limit is CLB and the pitch flight mode annunciation is VNAV SPD.

Another method to start a cruise climb: set a higher MCP altitude, enter the altitude into the CRZ ALT line, then execute.



77716074

① During Cruise Climb

VNAV page title displays **CRZ CLB** in a climb to cruise altitude.

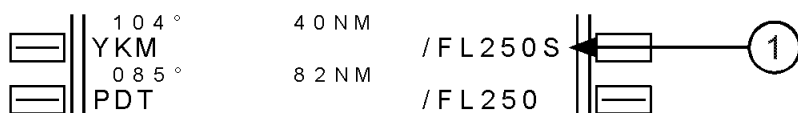
② End of Cruise Climb

VNAV page title displays **ECON CRZ** after level off at cruise altitude.

Planned Step Climb

When a step climb is planned to start at a waypoint, the data can be entered on the RTE LEGS page. The FMC performance predictions assume the airplane will start the climb at the identified waypoint.

The FMC shows the distance and ETA to the step point on the PROGRESS page. The corresponding altitude profile point and identifier is shown on the ND.



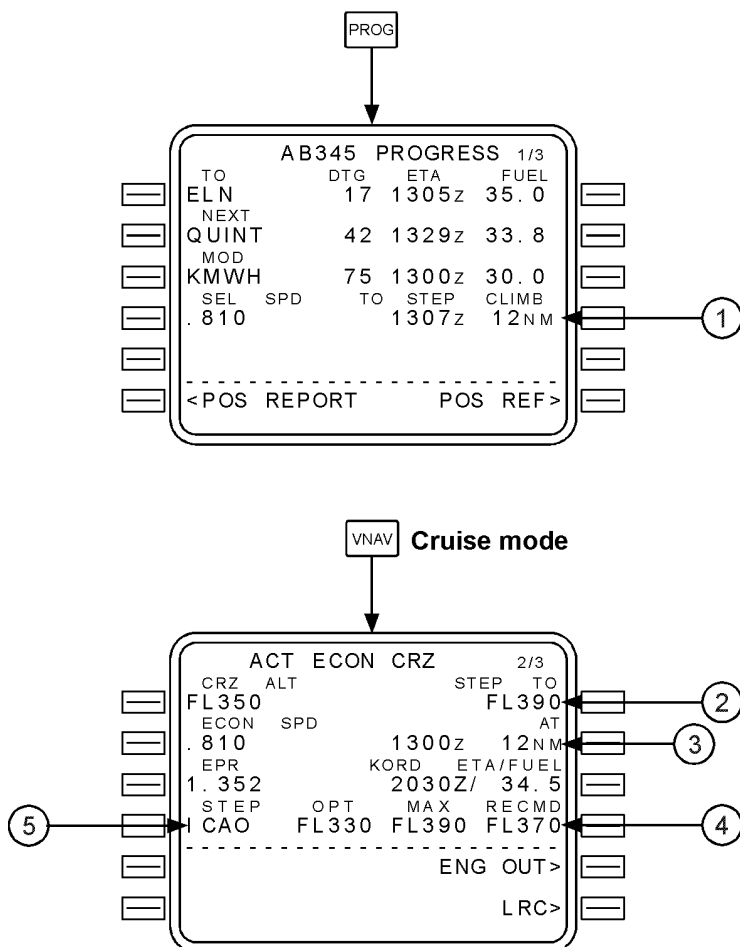
77716075

① Step Climb Altitude

Enter the cruise altitude as an altitude constraint and the letter S. The FMC assumes the step climb starts at the waypoint. Accomplish the step climb at the waypoint with the steps described in cruise climb.

Calculated Step Climb

When a nonzero value is entered into the STEP SIZE line on the PERF INIT or CRZ page, the FMC calculates optimum points for step climbs as the airplane performance permits. The climb altitude is determined by the value in STEP SIZE. Multiple step climbs are possible based on performance and route length.



① TO STEP CLIMB

When the cruise climb start point is the next VNAV event, the line title changes to **TO STEP CLIMB**.

Shows the ETA and DTG to the point where the step climb starts.

When the airplane passes the step climb point and has not started to climb, the ETA and DTG are replaced with the word **NOW**.

When the FMC calculates that a step climb is not advised, the ETA and DTG are replaced with the word **NONE**.

② STEP TO

An altitude can be entered for a step climb evaluation. The FMC calculates the predicted step climb data and shows the results on this page and the PROGRESS page.

Entering a zero value for **STEP SIZE** calculates performance based on a constant altitude flight at the **CRZ ALT**. Entering a valid, nonzero increment or ICAO step size calculates performance based on accomplishing step climbs at calculated step climb points.

Step climb altitudes entered on the RTE LEGS page can be greater than or less than the **CRZ ALT**. These step climb altitudes cannot be overwritten on the CRZ page.

When using the ICAO step size, the **STEP TO** altitude is the next higher altitude above the **OPT** altitude corresponding to the direction of flight, based upon the **CRZ ALT** entered before takeoff. Changes to **CRZ ALT** while in flight do not affect calculation of **STEP TO** altitudes using ICAO step sizes. Changing to an alternate RTE in flight calculates hemispheric altitude based on the FMC **CRZ ALT**.

When using an altitude increment step size, the **STEP TO** altitude is the next higher altitude above **OPT** calculated by adding the **STEP SIZE** increment to the FMC **CRZ ALT**.

When entering a cruise altitude above maximum altitude, the scratchpad message **MAX ALT FLXXX** displays.

Entry of a new cruise altitude deletes all waypoint altitude constraints at or above the new cruise altitude.

Shows:

- The **STEP TO** altitude from the RTE LEGS page
- A calculated step climb altitude based on the step size.

Manual entry is allowed.

Blank when:

- There is no active flight plan, or
- Within 200 NM of the T/D point, or
- In the **EO D/D** phase.

③ **AT**

Shows the ETA and DTG to the step climb point where a climb to the **STEP TO** altitude minimizes trip cost (**ECON CRZ**) or fuel (other CRZ speed).

Shows **NOW** passing the optimum step climb point.

Line title changes to **AVAIL AT** when the climb is restricted by thrust or buffet.

Line title changes to **TO T/D** when within 200 NM of the top of descent point. ETA and DTG are relative to the T/D point.

The data is the same as shown on the PROGRESS page.

④ Optimum Altitude, Maximum Altitude and Recommended Altitude (**OPT MAX RECMD**)

Blank when RTA is active.

OPT –

- With **ECON** speed selected, displays altitude which minimizes trip cost based on weight and cost index.
- With **LRC**, **EO**, **CO** or **SEL** speed selected, displays altitude which minimizes trip fuel based on weight.
- Does not reflect the effect of speed if speed intervention (MCP IAS/MACH window) is selected.

MAX – Displays maximum sustainable altitude based on:

- Current gross weight
- Temperature
- Number of engines operating
- Cruise reference thrust limit default set by airline (CLB)
- Speed (ECON, LRC, SEL, EO or CO) option
- Residual rate of climb default set by airline (range: 100 to 999 feet per minute)
- Disregarding altitude or speed constraints
- Does not reflect the effect of speed if speed intervention (MCP IAH/MACH window) is selected.

RECMD – Displays the most economical altitude to fly for the next 500 NM based on gross weight; selected cruise speed, including specified cruise speed segments; and constraint altitude cruise over a fixed distance taking into account the route of flight, entered winds and temperature forecast. The FMC evaluates altitudes up to 9,000 feet below the current CRZ ALT and up to less than MAX altitude. Recommended altitudes are selected consistent with the step climb schedule and specified step size. If a step size of zero has been selected, the recommended cruise level is selected assuming 2,000 feet step size. The recommended altitude is set to the CRZ ALT when within 500 NM of the T/D.

Note: The recommended altitude may be above or below cruise altitude. Refer to RTE DATA and WIND pages for wind and temperature data.

⑤ **STEP SIZE**

Shows the default step climb size of ICAO.

Valid entries are altitudes from 0 to 9000 in 1000-foot increments.

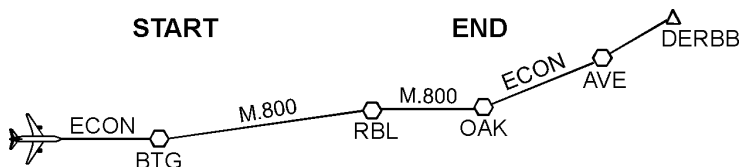
Used for calculation of optimum step point and step climb predictions.

Deletion of a manual entry defaults back to ICAO.

Constant Speed Cruise

A speed for a cruise segment can be specified. A cruise segment has a start waypoint and an end waypoint. The airplane maintains a constant speed between the two waypoints. The waypoints must be in the cruise phase. The FMC controls the speed after the end waypoint or top of descent.

Modification must be executed.



MOD RTE 1 LEGS		1 / 4
1	BTG	165° 38 NM .800 / FL350
	RBL	156° 337 NM .800 / FL350
2	OAK	162° 142 NM ECON / FL350
	AVE	121° 165 NM .808 / FL350
	DERBB	129° 29 NM .808 / FL350
	<ERASE	RTE DATA

77716120

① Start Waypoint for Constant Speed Cruise

The constant speed cruise starts at BTG at .800 Mach. Entry is in Mach.

② End Waypoint for Constant Speed Cruise

The constant speed cruise ends at OAK then ECON speed is used. If an RTA waypoint exists at RBL or OAK, the RTA is deleted.

Entry can be a Mach number, ECON/ or E/, LRC/ or L/. If an RTA waypoint is in the flight plan, RTA/ or R/ may be entered.

If no end waypoint is specified, the constant speed terminates at top of descent.

The FMC may select the end waypoint if a RTA waypoint is entered. The FMC selects the end waypoint to allow enough distance to arrive at the RTA waypoint on time. In the example, if the FMC selected OAK as the end waypoint, RTA would replace ECON. See RTA PROGRESS page 3/3.

Cruise Descent

Setting an altitude below the current altitude in the MCP altitude window and pushing the altitude selector (more than 50 NM from a T/D) causes the cruise altitude to be set to the MCP altitude and the airplane to descend to the new altitude. The CRZ page displays **ACT ECON CRZ DES**. If the altitude set in the altitude window is below the speed transition (SPD TRANS) or restriction (SPD RESTR) altitude displayed on the DES page, those altitudes and speeds are deleted. Transition or speed restrictions must be maintained by flight crew action. A VNAV cruise descent is commanded at cruise speed and approximately 1250 feet per minute.

The autothrottles adjust thrust to maintain the target descent rate; pitch maintains the commanded speed. The thrust levers can be manually positioned to adjust the descent rate.



77716077

① During Cruise Descent

Page title shows VNAV phase is cruise in a descent to cruise altitude.

② End of Cruise Descent

Page title shows VNAV phase is cruise after level off at cruise altitude.

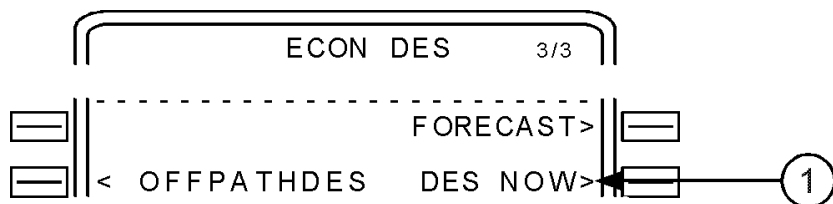
Descend Now (DES NOW)

When a Descend Now is initiated (**DES NOW** function active), the VNAV phase is descent and the DES page becomes active.

During cruise, setting an altitude below the current altitude in the MCP altitude window and pushing the altitude selector activates the **DES NOW** function when the airplane is within 50 nm of the T/D or if the MCP altitude is set below the highest descent altitude constraint in the VNAV descent profile.

The autothrottle sets thrust to maintain the target descent rate; then annunciates **HOLD**. Pitch maintains the commanded speed. Thrust levers can be manually positioned to adjust the descent rate.

Another method to accomplish a Descend Now: set a lower MCP altitude, page forward to the VNAV DES page and line select **DES NOW**, and execute.



77716078

① DES NOW

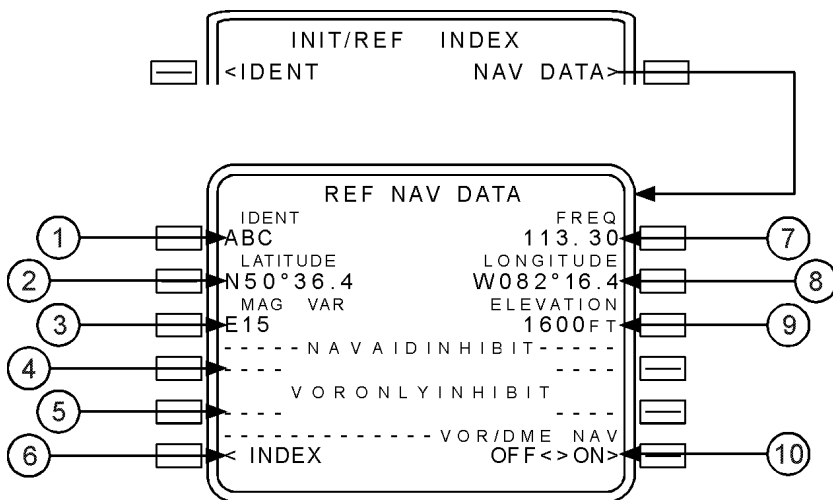
The **DES NOW** prompt is shown on the descent page when the cruise phase is active. Select the **DES NOW** prompt and execute to start a VNAV ECON descent of approximately 1250 feet per minute at ECON speed.

Upon reaching the planned descent path, VNAV commands pitch to maintain the planned descent path and ECON speed. If the airplane reaches an altitude constraint, **VNAV SPD** changes to **VNAV ALT** until the planned descent path is intercepted, then it changes to **VNAV PTH**.

Navigation Data

Reference Navigation Data Page

The reference navigation data page shows data about waypoints, navaids, airports, and runways. Use this page to inhibit FMC position updates from radio navaids. The navaids are always available for manual tune, autotune and the ND.



77715079

① Identification (**IDENT**)

Valid entries are any waypoint, navaid, airport, or runway from the navigation database.

Entry changes to dashes when page is exited and then reselected.

② **LATITUDE**

Shows the latitude of the entered identifier.

③ **Magnetic Variation (MAG VAR), Length**

MAG VAR – Displays magnetic variation when entered identifier is a navaid.

LENGTH – Displays runway length when entered identifier is a runway.

④ **NAVAID INHIBIT**

Valid entries are: VOR, VOR/DME, VORTAC, or DME identifiers from the navigation database.

Inhibits use of entered navaids for updating by both FMCs.

Entries are blanked at flight completion.

Deleting or overwriting removes a previous inhibit.

⑤ **VOR ONLY INHIBIT**

Valid entries are VOR identifiers from navigation database.

Inhibits use of only VOR portion of entered navaid for updating by both FMCs.

Entries are blanked at flight completion.

Deleting or overwriting removes a previous inhibit.

⑥ **INDEX**

Push - Shows the INIT/REF INDEX page.

⑦ **FREQUENCY (FREQ)**

Shows the frequency of the entered identifier, if it is a navaid.

⑧ **LONGITUDE**

Shows the longitude of the entered identifier.

⑨ **ELEVATION**

Shows the elevation of the entered identifier if it is a navaid, airport, or runway.

⑩ **VOR/DME NAV**

Push - Alternately selects **VOR/DME NAV ON** (active) and **OFF** (inactive).

ON - VOR/DME data is supplied to the FMC for position updates. **ON** is shown in large green letters and **OFF** is shown in small white letters.

OFF - VOR/DME data is not available to the FMC. **OFF** is shown in large green letters and **ON** is shown in small white letters. DME – DME position updating is not inhibited.

Selecting **OFF** shows ALL in both locations of the VOR ONLY INHIBIT line.

Fix Information Page

Two identical FIX INFORMATION pages are used to create waypoint fixes and waypoints for the ND. Some of the created waypoints can be copied into the route.

Magnetic/True Bearing

Magnetic or true fix bearings depend on where the airplane is operating. Refer to FMC Polar Operations, Flight Management, Navigation, Section 6.11.

FIX

↓

① →

② →

③ →

④ →

⑤ →

⑥ →

1/2

FIX	BRG/DIS	FR			
ABC	111/ 29		←		
	BRG/DIS	ETA	DTG	ALT	
<input style="width: 40px;" type="text"/>	130/ 24	2004z	10	12000	
<input style="width: 40px;" type="text"/>	180/ 26	2006z	32	FL190	
<input style="width: 40px;" type="text"/>	- - / - - -				
ABEAM					
<input style="width: 40px;" type="text"/>	150/ 23	2008z	18	15500	
<input style="width: 40px;" type="text"/>	<ERASE FIX		PRED	ETA	ALT
<input style="width: 40px;" type="text"/>	ABC180.0/026.4		112NM	2108z	

→ ⑦

→ ⑧

77716080

① FIX

Enter the fix. Valid entries are airports, nav aids, and waypoints from the navigation database. The selected fix is shown on the ND and highlighted by a green or cyan circle.

② Bearing/Distance (**BRG/DIS**) - Distance Entry

Valid entries XXX/YYY.Y:

- Decimal values can be omitted.
- Leading zeros can be omitted for distance entries.
- Distance only entries must start with a (/).

Distances from the fix display on the ND as a circle around the fix.

When the circle intersects the active route, the ETA, DTG, and predicted altitude at the intersection display for the closest of the two intersections.

Bearings from the fix display on ND as radial lines from the fix.

When the bearing intersects the active route, the ETA, DTG, and predicted altitude at the intersection display.

ETA – Displays the estimated time if arrival to the intersection point.

DTG – Displays the distance to go to the intersection point.

ALT – Displays the predicted altitude at the intersection point.

Push – copies the fix place/bearing/distance into the scratchpad. This fix can be placed in the route on a LEGS or RTE page as a waypoint.

③ Bearing/Distance (**BRG/DIS**) - Dashes

Enter a bearing, distance, or both bearing and distance from the fix. A bearing and distance from the fix displays on the ND as a waypoint fix point. **ETA**, **DTG**, and predicted do not display.

④ **ABEAM**

Displays **ABEAM** prompt.

Push – Displays bearing and distance from the fix perpendicular to the nearest segment of the flight plan path, and ETA, DTG, and altitude at the intersection point.

Second push – Copies the fix place/bearing/distance into the scratchpad. This fix can be placed in the route on a LEGS or RTE page as a waypoint.

⑤ **ERASE FIX**

Push - Removes all fix data from the page and the ND.

⑥ Route Intersection Point Copied

Pushing the line select key for one of the BRG/DIS entries copies the fix place/bearing/distance definition into the scratchpad. This fix can be placed into the route on a LEGS page as a waypoint.

⑦ Bearing/Distance From (**BRG/DIS FR**)

Shows the bearing and distance of the airplane from the fix.

⑧ Predicted Distance to ETA or Altitude (**PRED ETA-ALT**)

Valid entry is altitude, flight level, or time. Time entry must be followed by “Z.”

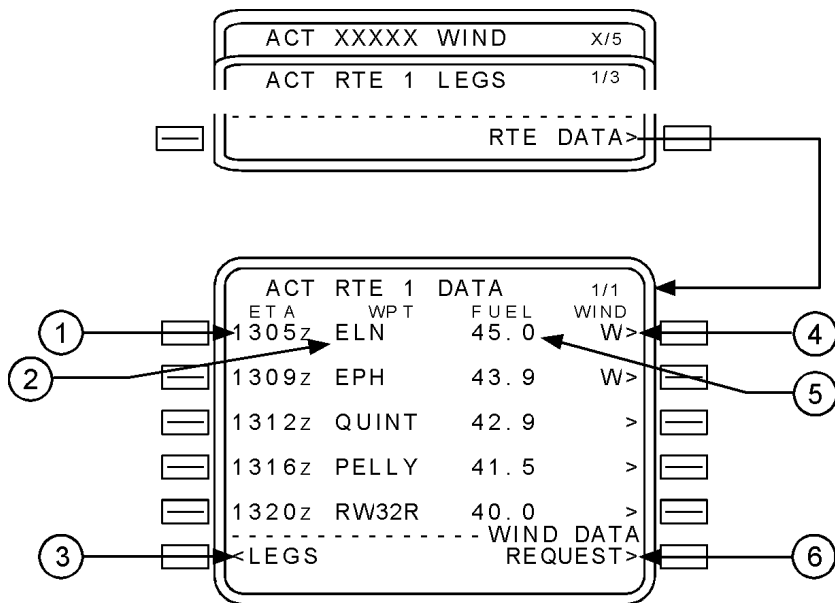
Entering an altitude or flight level displays the predicted along track distance and altitude or flight level on this line. The predicted airplane position displays on the ND route line as a green circle with the entered altitude/flight level.

ROUTE AND WAYPOINT DATA

Route Data Page

The route data page shows progress data for each waypoint on the ACT RTE X LEGS page. This page also allows access to the WIND page. This page is available only for the active route.

The ETA and calculated fuel remaining at the waypoint are shown for each waypoint. Manual entry is not possible.



77716081

- ① **ETA**
Shows ETA for waypoint.
- ② **Waypoint (WPT)**
Shows identifier for waypoint.
- ③ **LEGS**
Push - Shows RTE LEGS page.

④ WIND

W> - Indicates waypoint winds have been entered.

> - Winds not entered.

Push – Selects WIND page for the selected waypoint.

⑤ FUEL

Shows the FMC calculated fuel remaining at the waypoint.

Note: ETA and estimated fuel calculations assume a direct flight across route discontinuities.

⑥ WIND DATA REQUEST

Push - Transmits a data link request for wind and descent forecast data.

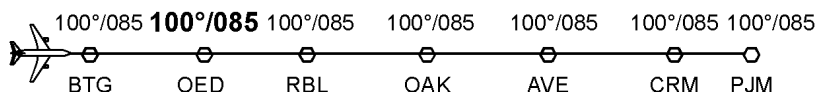
Flight Crew may enter up to four altitudes on any wind page to qualify the request.

Wind Data

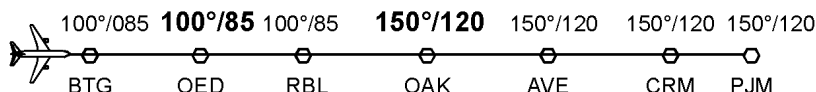
The FMC uses wind data to improve performance prediction accuracy. Wind data includes altitude and direction/speed.

The FMC puts the first entered wind data into all waypoints in the flight plan, before and after the selected waypoint. Wind data entered at a second waypoint at the same altitude changes wind data up to the first entered wind data. The wind data before this does not change. Therefore, enter wind data for waypoints closest to the airplane, then enter wind data for waypoints farther from the airplane.

For example, at FL 350 100°/085 is entered at waypoint OED. All waypoints in the route have the OED wind data. Then, additional wind data entered at OAK changes the wind data at OAK and through the end of the route.



First Waypoint (OED) - FL350, 150°/085 wind entered at OED



Second Waypoint (OAK) - FL350, 150°/120 wind entered at OAK

77716082

Entered wind data are mixed with sensed wind data for performance predictions. The FMC uses entered winds for predictions far ahead of the airplane and sensed winds close to the airplane. The FMC mixes these winds for predictions in between. Sensed winds display on the progress page 2/3.

Inaccurate forecast wind and temperature information degrades the accuracy of the recommended altitude displayed on the cruise page.

The FMC adjusts ECON climb speed and top of climb using entered and/or sensed wind speed. FMC calculated ECON climb speed may fluctuate if top of climb is near a waypoint with approximately a 45 degree or larger track change and if a significant wind velocity has been entered or is predicted for that waypoint. This fluctuation does not occur when using a manually entered climb speed or speed intervention.

Wind Page

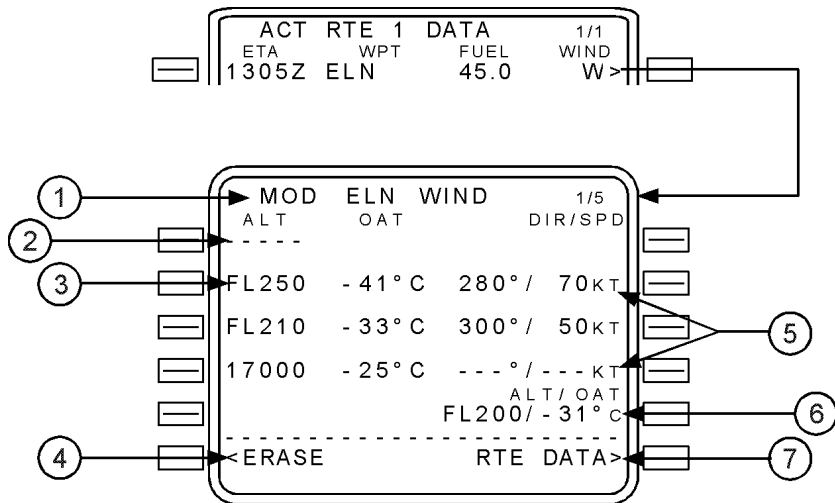
The wind page is used to enter forecast winds and temperatures at specific altitudes for specific waypoints to enhance VNAV performance. The FMC calculates step climb points based on the wind effect but does not calculate step climb points based on wind data entered at the step climb altitude.

This data can be uplinked or manually entered.

The altitudes are entered first. The altitudes can be entered in any order and are sorted and shown in ascending order.

Wind speed and direction are entered for the specific altitudes.

OAT can be entered for any altitude. The FMC calculates the temperature for the entered altitudes using the standard lapse rate.



77716083

① Page Title

Shows ACT XXXXX, where XXXXX is the waypoint for which the winds are shown.

When a route is being modified, **MOD** in shaded white is shown in the page title.

② Altitude (**ALT**)

Enter altitude or flight level for wind entries. Altitude data entry possible only on line 1L.

After data entry, data is sorted by altitude and placed in lines 1 through 4. Dashes are shown on right side of line for wind direction and speed entry.

When all four lines have data, one must be deleted before new data can be entered.

③ Altitude/Flight Level Data

Shows the altitude or flight level for wind or OAT entries.

Data entered on 1L is shown on lines 1 through 4. Data entry not possible in lines 2L through 4L.

OAT shows the outside air temperature. Entries made using the ALT/OAT line are shown in large font. Calculated OAT, based on standard lapse rate, is shown in small font.

④ **ERASE**

Push - Removes the modified data.

⑤ Direction and Speed (**DIR/SPD**)

Shows dashes after altitude/flight level is entered in the ALT line. Enter wind direction and speed for the altitude.

Shows entered wind direction and speed for related altitude.

Values propagate in both directions for the first wind entered and downtrack for other entered winds. Propagated values display in small white font.

Manual entries are shown in shaded white until executed, then in large white font.

⑥ Altitude/Outside Air Temperature (**ALT/OAT**)

Enter the altitude and its OAT. The altitude for OAT does not have to be one of the wind altitudes. The FMC uses standard lapse rate to calculate and show the temperature at the other altitudes.

Manual entries are shown in shaded white until executed.

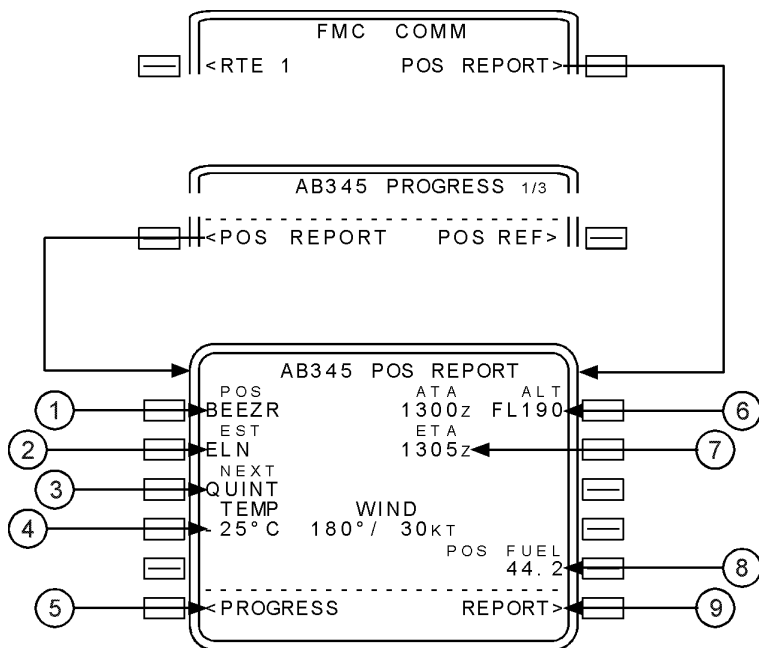
⑦ Route Data (**RTE DATA**)

Push - Shows the RTE DATA page.

Position Report Page

The position report page shows data for a position report. A position report can be data linked from the page.

The page contains reference data only. Manual entries are inhibited.



77716084

① Position (**POS**)

Waypoint to use to report position. This is the previous active waypoint.

② Estimate (**EST**)

The active waypoint is shown in magenta.

③ **NEXT**

Waypoint after active waypoint.

④ Temperature and Wind (**TEMP WIND**)

TEMP shows the OAT in °C.

WIND shows the wind direction and speed.

⑤ **PROGRESS**

Push - Shows the PROGRESS page.

⑥ Actual Time of Arrival and Altitude (**ATA ALT**)

ATA shows the actual time of arrival for the POS waypoint.

ALT shows the airplane altitude at last waypoint.

⑦ **ETA**

Shows the estimated time of arrival for the active waypoint.

⑧ Position Fuel (**POS FUEL**)

Shows the fuel on board at the POS waypoint.

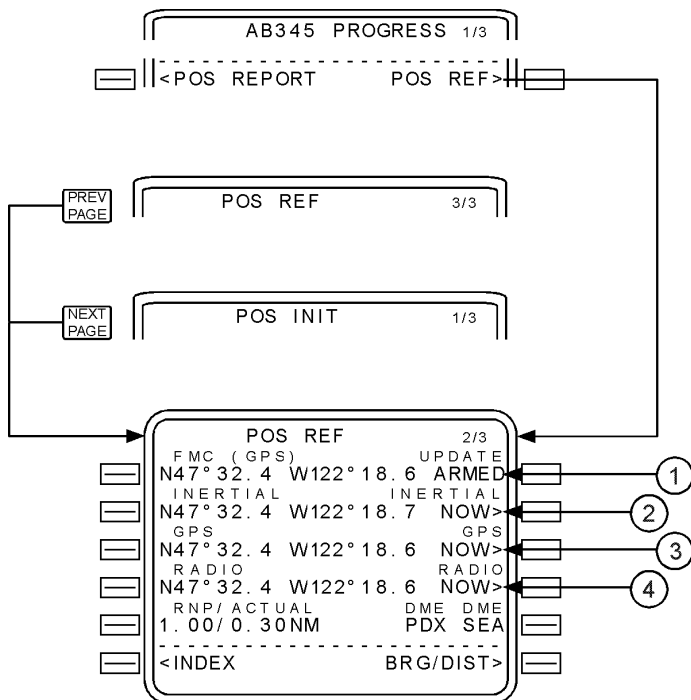
⑨ **REPORT**

Push - Transmits a data link downlink of the data on this page.

The data link transmission of a position report requires the data link not be in the voice or no-communications mode.

INTENTIONALLY LEFT BLANK

In-Flight Position Update



77716085

FMC position update is accomplished on the POS REF 2/3 page in flight.

① UPDATE ARMED

Pushing the **ARM** prompt arms the position update function. **ARM** changed to **ARMED**. Each of the position update sources have a **NOW** prompt.

② INERTIAL NOW

Push - To update the FMC position from the inertial position.

③ GPS NOW

Push - To update the FMC position from the GPS position.

④ RADIO NOW

Push - To update the FMC position from the navigation radio position.

PROGRESS PAGES

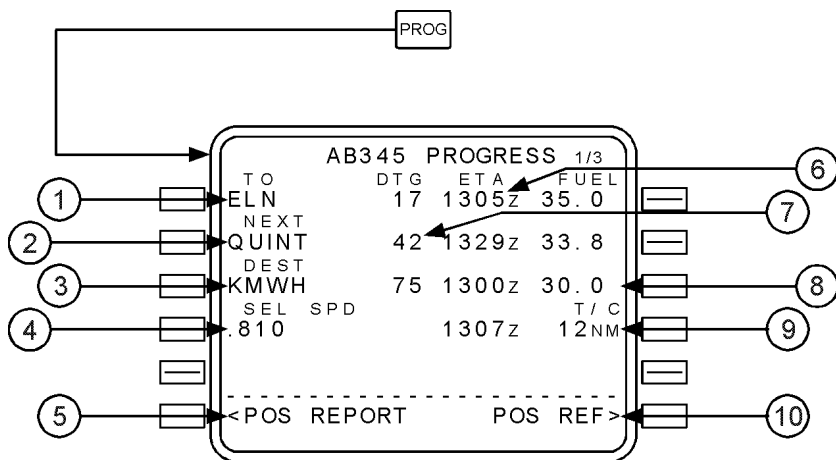
Progress Page 1/3

The progress page shows general flight progress data. The FMC Cruise section of this chapter shows how to make position reports with the progress page.

The page title shows the company flight number entered on the RTE page.

Page one of the progress pages shows general data about:

- Waypoints (active and next)
- Destination data
- FMC speed
- Cruise altitude.



77716086

① TO

Active waypoint on active leg and is shown magenta.

Can not be modified.

② NEXT

Waypoint after TO waypoint and is shown white.

Can not be modified.

③ Destination (**DEST**)

Any waypoint or airport in navigation database can be entered. The line titles are:

- **DEST** - Performance predictions to destination. Default display.
- **DIR TO FIX** - When entered waypoint is not in flight plan is entered. Data shown is based on flying present position direct to the waypoint.
- **EN ROUTE WPT** - When entered waypoint is in flight plan. Line data are based on flying the flight plan route to the waypoint.
- **MOD** - A modification has been made on another page. Performance predictions include modification.

Remove entries with DELETE key or change all CDUs to a different page.

④ Selected Speed (**SEL SPD**)

The speed line shows the FMC active command speed in magenta.

The active speed mode is the same as shown on the performance page, unless changed by the MCP or a limit. The speed modes are:

- | | |
|---|--|
| • LRC SPD - Long range cruise speed | • MCP SPD - MCP speed entered on the MCP IAS/MACH indicator |
| • ECON SPD - Economy speed | • EO SPD - Engine out speed |
| • SEL SPD - Selected speed manually entered on the CDU | • CO SPD - Engine out operations at airline specified engine out company speed |
| • LIM SPD - Speed is limited by VMO, MMO, flap limit, or buffet limit | • $V_{REF} + 80$, for engine out operations during takeoff. |

⑤ Position Report (**POS REPORT**)

Push - Shows the POS REPORT page.

⑥ **ETA**

Estimated time of arrival at waypoint or destination.

⑦ Distance To Go (DTG)

Distance to go to waypoint or destination.

⑧ FUEL

Estimated fuel remaining at waypoint or destination.

⑨ TO

ETA and DTG:

- T/C – top of climb
- E/D - End of descent data
- STEP CLB – step climb data
- LEVEL AT - Time and distance to level off in engine out mode.
- T/D – top of descent data

⑩ Position Reference (POS REF)

Push - Shows position reference page.

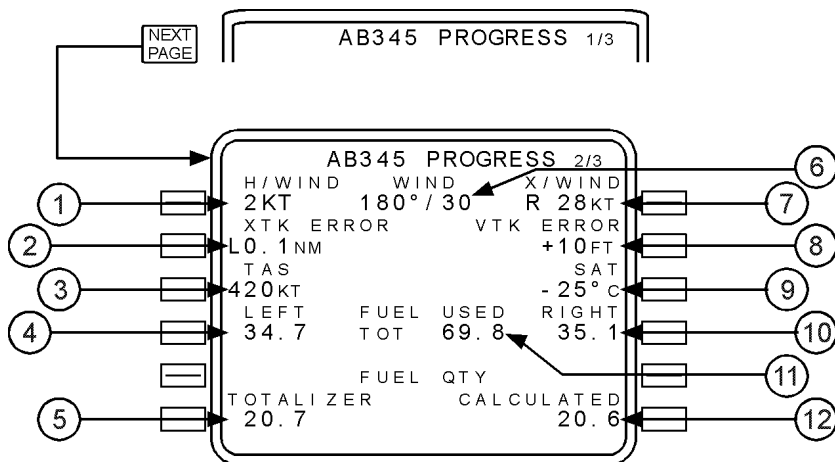
Note: The Flight Management Computer System (FMCS) does not contain special provisions for operation with landing gear extended. As a result, the FMCS will generate inaccurate enroute speed schedules, display non-conservative predictions of fuel burn, estimated time of arrival (ETA), and maximum altitude, and compute overly shallow descent path.

To obtain accurate ETA predictions, gear down cruise speed and altitude should be entered on the CLB and CRZ pages of the Control and Display Unit (CDU). Gear down cruise speed should also be entered on the DES page and a STEP SIZE of zero should be entered on the PERF INIT or CRZ page. Use of the VNAV during descent, under these circumstances is not recommended.

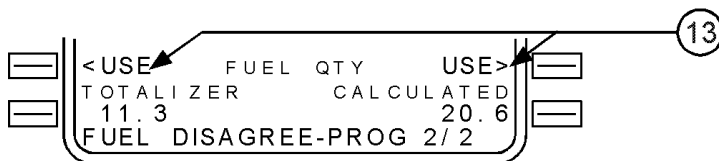
Progress Page 2/3

Progress page two contains:

- Wind data
- Fuel data
- Static air temperature
- True airspeed
- Track error data.



77716087



77716088

- ① Headwind (H/WIND), Tailwind (T/WIND)
Headwind component (H/WIND).
Tailwind component (T/WIND).
Wind component data is relative to the airplane.
- ② Crosstrack Error (XTK ERROR)
Crosstrack (XTK) error in nautical miles left or right of the active route.
- ③ TAS
Airplane true airspeed.

④ LEFT FUEL USED

Fuel consumed by left engine sensed by fuel flow meters.

⑤ Fuel Quantity Totalizer (FUEL QTY TOTALIZER)

Fuel quantity calculated by the fuel quantity system totalizer.

The fuel remaining line shows two independent fuel remaining values, **TOTALIZER** and **CALCULATED**. They can be compared to validate FMC calculations.

⑥ WIND

Displays current wind direction and speed referenced to true north.

⑦ Crosswind (X/WIND)

Left (**L**) or right (**R**) crosswind component relative to airplane heading.

⑧ Vertical Track Error (VTK ERROR)

Vertical path (**VTK**) error above (+) or below (-) vertical path.

⑨ Static Air Temperature (SAT)

Outside static air temperature.

⑩ RIGHT FUEL USED

Fuel consumed by right engine sensed by fuel flow meters.

⑪ Total Fuel Used (TOT FUEL USED)

Sum of the **LEFT** and **RIGHT** fuel consumed values.

⑫ Fuel Quantity Calculated (**FUEL QTY CALCULATED**)

Fuel remaining as calculated by the FMC with these methods:

- Before engine start, fuel quantity calculated by fuel quantity system totalizer.
- After engine start, fuel quantity at engine start decreased by EICAS engine fuel flow rate.
- After fuel dump, resets to fuel quantity system totalizer.
- After landing, resets to fuel quantity system totalizer.

The fuel remaining line shows two independent fuel remaining values, **TOTALIZER** and **CALCULATED**. They can be compared to validate FMC calculations.

⑬ **USE**

Push - Selects method to calculate fuel quantity, either **TOTALIZER** or **CALCULATED**.

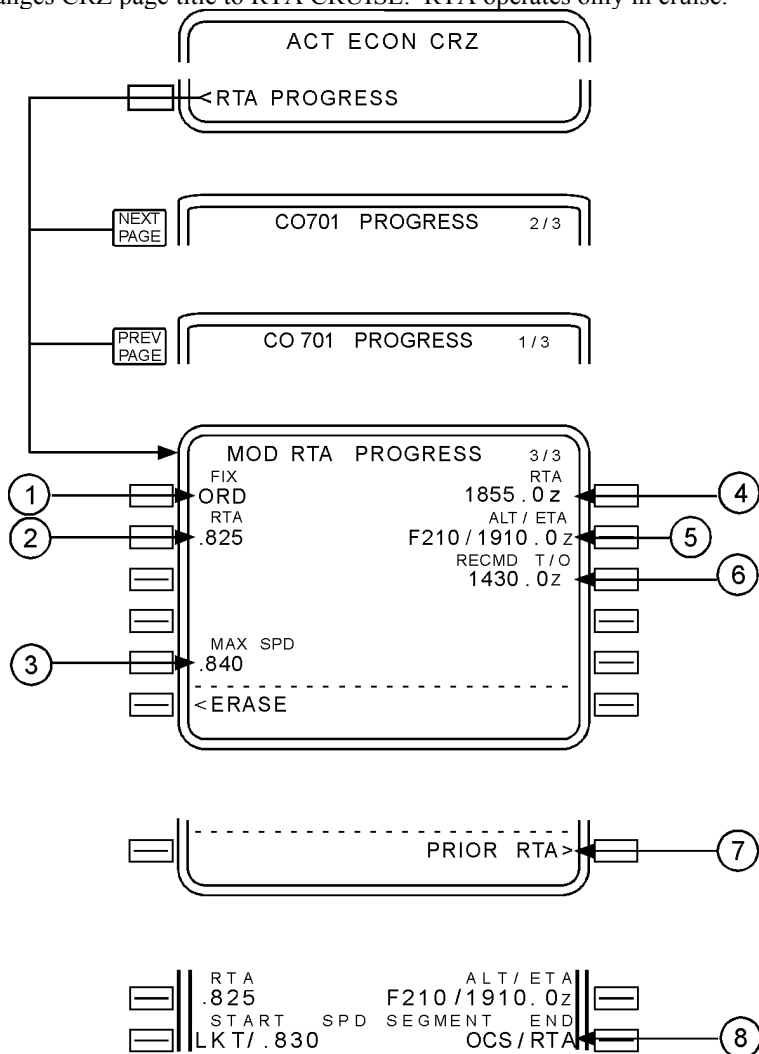
When one is selected:

- It is used for remainder of flight.
- The other fuel calculation method blanks.
- Scratchpad clears.

Scratchpad message **FUEL DISAGREE-PROG 2/3** and **USE** prompts are shown when **TOTALIZER** and **CALCULATED** values disagree by more than approximately 9000 pounds for 5 minutes.

RTA Progress Page 3/3

Progress page three is used to enter data for required time of arrival (RTA). RTA can be entered or changed during preflight or in flight. Creating an RTA changes CRZ page title to RTA CRUISE. RTA operates only in cruise.



① **FIX**

Valid entry is a waypoint in the active or pending active route. Waypoints defined by coordinates must be down selected to the scratchpad, then selected to the FIX line.

Entry by flight crew or data link.

Entry displays ALT/ETA data on line 2R.

When RTA active, deletion of FIX terminates RTA and resumes ECON. Display returns to boxes.

When RTA not active, deletion of FIX erases a pending RTA MOD. Display returns to boxes.

Defaults to boxes except when on ground or an engine-out mode active; then it is blank.

② **Required Time of Arrival Speed (RTA SPD)**

Displays FMC computed cruise speed to accomplish RTA.

Blank if no RTA fix or time entered, or with descent active.

③ **Maximum Speed (MAX SPD)**

Valid entry is Mach .100M to .990M.

Deletion of entered value displays default Mach.

Default Mach .850M displays in small font.

④ **Required Time of Arrival (RTA)**

Boxes are shown after entering RTA FIX.

Valid entry is time from 000.0 to 2359.9. Decimal entry of .0 is optional. Entry of Z character is not allowed.

Suffix to RTA indicates:

- No suffix - Arrive at entered time
- A - Arrive at or after entered time
- B - Arrive at or before entered time.

Entry shows recommended T/O time.

Deletion terminates **RTA** and returns **ECON** as cruise mode.

⑤ Altitude/ETA (**ALT/ETA**)

Predicted altitude and ETA at RTA fix.

Not shown until FIX is entered in 1L.

Blank until performance data is entered.

⑥ Recommended Takeoff (**RECMD T/O**)

Displays recommended takeoff time to meet RTA at ECON speed.

Dashes until FIX is entered.

Blanks in flight.

Valid entry is time from 0000.0 to 2359.9. Decimal entry of .0 is optional.

Manual entry recalculates all flight plan time predictions.

Changes to **NOW** after recommended takeoff time.

When unable to meet the RTA based on a manual takeoff time entry, **UNABLE RTA** displays.

⑦ **PRIOR RTA**

Displays when RTA not active but RTA fix and time previously entered and activated.

Push –

- Displays previously active RTA fix and time.
- Initiates RTA modification.

⑧ Constant Speed Cruise

Shows constant speed cruise start and end waypoint.

FMC DESCENT AND APPROACH

Introduction

The descent phase starts at the top of descent point and continues to the end of descent point. Planning for the descent phase starts during cruise.

The approach phase starts at the end of descent point and continues to touchdown or go-around. When a go-around is accomplished, the FMC enters a modified cruise or approach phase, depending on the route and cruise conditions.

Alternates can be selected at any time. Alternates are available from preflight through all phases of flight and can be updated at any time. Diversion to an alternate can be accomplished during cruise, descent, or approach.

The only automatic page change in the descent/approach phases is the VNAV selected page change from cruise to descent at the top of descent.

Early Descent

The description of early descent options and functions is in this section, FMC Cruise.

Descent

During descent, LNAV progress is managed using the RTE LEGS and PROGRESS pages, as in the cruise phase. VNAV descent management is accomplished primarily on the DES page.

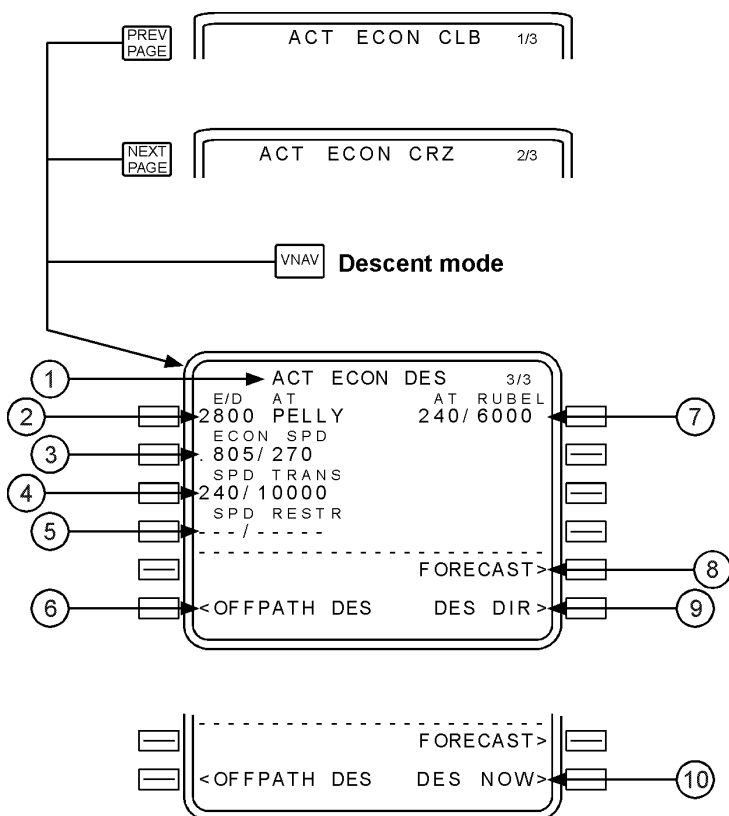
Other pages which support descent are:

- DESCENT FORECAST page - To enter forecast wind data to aid descent planning.
- OFFPATH DES page - To analyze descent performance with and without the use of speedbrakes.
- ALTN page- To manage the selection of alternate airports and diversions.

Descent Page

The descent page is used to monitor and revise the descent path. Descent speed modes are economy (ECON) and fixed speed (SEL). The default VNAV descent mode is ECON. A fixed speed descent is flown when speed intervention is used or a speed is entered on the DES page. The descent page is blank with DES as the title until an altitude constraint below the cruise altitude is entered.

This page title includes the VNAV speed mode. The ECON mode controls descent speed at the economy speed until reaching a lower speed restriction. The fixed speed mode controls descent speed at the fixed speed until a lower speed restriction is reached.



① Page Title

The page title displays active (**ACT**) or modified (**MOD**) descent. Usually, the title displays **ECON** for economy descent. Fixed speed descents modify the title.

The page title shows the type of descent:

- ECON - Speed based on a cost index
- LIM SPD - Speed based on airplane configuration limiting speed
- MCP SPD - MCP speed intervention is selected
- XXXKT - Fixed CAS descent speed profile
- M.XXX - Fixed Mach descent speed profile
- END OF DES – E/D AT waypoint reached if not followed by a climb segment.

Fixed descent speeds are for:

- A flight crew entered selected speed (**SEL SPD**)
- A speed transition
- A speed restriction associated with an altitude constraint
- Waypoint speed constraints.

② End Of Descent at (**E/D AT**)

Shows the end of descent altitude and waypoint.

The end of descent point is a waypoint in the descent phase with the lowest altitude constraint.

The altitude is shown in magenta when altitude becomes the FMC altitude target.

Waypoint is shown in magenta when E/D waypoint becomes the active waypoint.

Page is blank if no E/D point exists.

③ Economy Speed (**ECON SPD**), Selected Speed (**SEL SPD**)

Both CAS and Mach values are shown.

ECON SPD -

- Economy speed based on cost index
- Shows CAS and Mach values.

SEL SPD -

- Displays when flight crew enters speed
- Displays constraint speed on transitioning into a selected speed segment (waypoint speed constraint, **SPD RESTR**, or **SPD TRANS**)
- Valid entries are **CAS** or **MACH**.

The FMC commanded speed is magenta. Initially, **MACH** is magenta and **CAS** is white. Below CAS/Mach transition altitude, **CAS** is magenta and **MACH** is white.

④ Speed Transition (**SPD TRANS**)

The transition speed is usually 10 knots less than the destination airport limiting speed from the navigation database. When no airport limit speed exists, the default speed of 240 knots is shown. The transition altitude is the point that the transition speed is active for the destination airport. When no altitude exists in the navigation database, the default of 10,000 feet is shown.

Speed is shown in magenta when it is the FMC speed target.

Blanks below SPD TRANS altitude.

Deleting causes the airplane to fly economy or selected speed if not limited by a waypoint constraint or speed restriction.

⑤ Speed Restriction (**SPD RESTR**)

Speed restrictions at altitudes higher than E/D altitude, and not associated with specific waypoints, are manually entered on this line.

Valid entry is a CAS and altitude (example 240/8000). Entry may be deleted.

Magenta when it is FMC command speed.

⑥ Off Path Descent (OFFPATH DES)

Push - Shows the OFFPATH DES page.

⑦ AT XXXXX

Shows the next waypoint constraint from the RTE LEGS page.

XXXX is:

- The waypoint identifier
- **HOLD AT XXXXX**
- **AT VECTORS**
- **AT (INTC).**

The constraint is speed/altitude. Blank when no constraint exists.

Can be deleted on this page.

VNAV commands the lesser of constraint speed or present performance speed.

Speed and/or altitude are shown in magenta when they are the FMC target values.

⑧ FORECAST

Push - Shows the DESCENT FORECAST page.

⑨ Descend Direct (DES DIR)

Push - Deletes all waypoint altitude constraints between the airplane altitude and the MCP altitude. FMC cruise altitude is not affected.

Shown in descent phase with altitude constraint between airplane and E/D.

⑩ Descend Now (DES NOW)

Push -

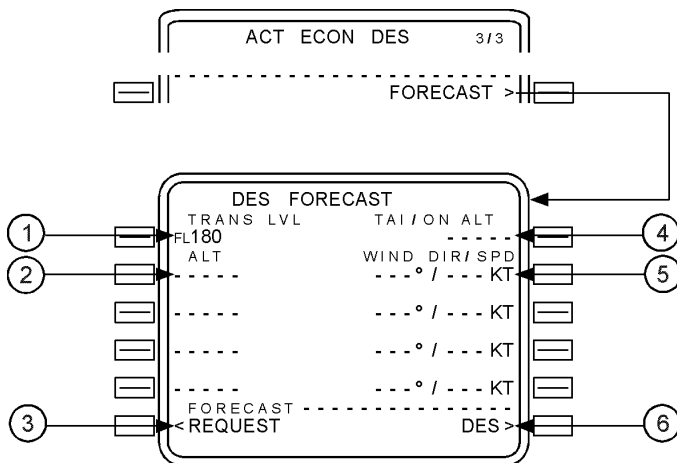
- Starts a 1250 feet per minute descent schedule until intercepting the planned descent path
- Activates the FMC descent phase.

Shown when the descent phase is not active.

Descent Forecast Page

The descent forecast page is used to enter wind data for descent, and the altitude at which anti-ice use is anticipated for more accurate descent path calculation.

The primary entries are wind direction and speed for up to four descent altitudes, and the altitude that anti-ice is turned on.



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① Transition Level (**TRANS LVL**)

Shows the transition level.

The transition level can be specified by the arrival procedure. The default transition level is FL 180.

Above transition level, altitudes are in flight levels. Below transition level, altitudes are in thousands of feet.

Valid entry is an altitude or flight level.

② Altitude (**ALT**)

Enter altitude of forecast wind data.

Altitudes and flight levels can be entered in any order. Entries are not sorted.

Execute not necessary.

③ **FORECAST REQUEST**

Push - Transmits a data link request for descent wind data.

④ Thermal Anti-Ice On Altitude (**TAI/ON ALT**)

Enter the altitude where anti-ice is first turned on during the descent.

⑤ Wind Direction/Speed (**WIND DIR/SPD**)

Enter the wind direction/speed for the specified altitude. Initial entry must have wind direction and speed; subsequent entries may have one or the other.

Execute not necessary.

⑥ Descent (**DES**)

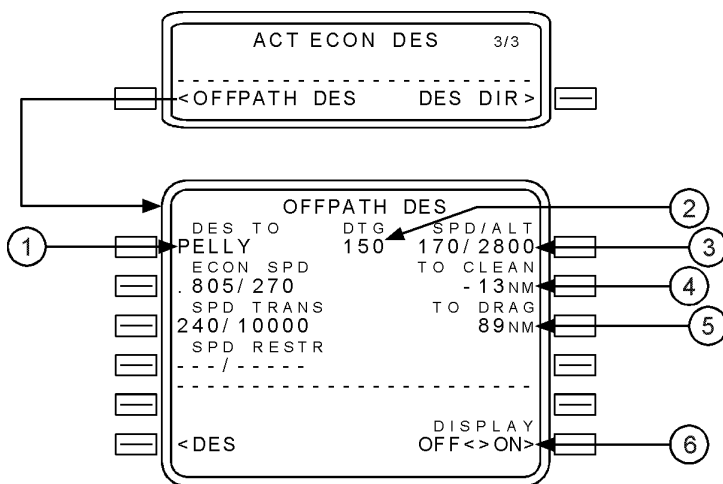
Push - Shows the DES page.

Offpath Descent Page

The offpath descent page allows the analysis of descent performance off the present route of flight, direct to a selected waypoint. Data entered on the page shows clean and drag descent ranges on the page and on the ND. The ranges are based on an entered waypoint and altitude constraint. The range can be used to determine if the altitude constraint can be met in a direct descent to the waypoint.

The FMC puts the last descent waypoint with an altitude constraint into DES TO.

The ECON SPD, SPD TRANS, SPD RESTR, and DES data are the same as the DES page.



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① Descend To (DES TO)

The waypoint for a direct-to descent. Usually, this is the E/D waypoint from the active route. Manual entry of waypoints on or off of the route are allowed. The DTG calculations are for a descent direct to the selected waypoint.

When within 150 feet of the **DES TO** altitude for a waypoint, other than the **E/D** waypoint, the display automatically changes the **DES TO** waypoint to the **E/D** waypoint from the DES page.

A waypoint is entered for direct-to analysis.

② Distance To Go (**DTG**)

Shows the straight-line distance to the entered waypoint.

③ Speed/Altitude (**SPD/ALT**)

Shows the speed/altitude constraint for the entered waypoint.

A manual waypoint entry shows boxes for manual speed and altitude entry.

④ **TO CLEAN**

Distance to the clean descent circle. The distance is negative when a clean descent is no longer possible.

A clean circle assumes no drag devices are used for descent.

A direct descent to the **DES TO** waypoint at a SPD/ALT constraint is possible when the airplane is outside the clean circle. The clean circle is shown on the ND when the **DISPLAY** prompt is **ON**.

⑤ **TO DRAG**

Distance to the drag descent circle. The distance is negative when a drag descent is no longer possible.

A drag circle assumes speedbrakes are UP for descent.

A direct descent to the **DES TO** waypoint at a SPD/ALT constraint is possible when the airplane is outside the drag circle. The drag circle is shown on the ND when the **DISPLAY** prompt is **ON** and the airplane is inside the clean circle.

⑥ **DISPLAY**

Push - Alternates between **ON** and **OFF**.

ON - Shows the clean and drag circles on the ND. The drag circle is not shown until the airplane position is inside the clean circle.

OFF - Removes the clean and drag circles from the ND.

Selected state is large green font, otherwise small white font.

Automatically changes to **OFF** within 150 feet of the waypoint constraint altitude.

Engine Out Descent

There are no specific engine out pages for descent. Use the two-engine descent planning features and pages.

Approach

During approach, roll and pitch modes usually change to the approach guidance supplied by navigation radios. The FMC continues to calculate and show present position and can supply LNAV and VNAV approach guidance for certain types of approaches when radio navigation is not used.

The RTE LEGS and PROGRESS pages are used to manage the airplane until other approach guidance becomes active. Other pages which support approaches are:

- APPROACH REF page - To specify approach flap settings and set the approach VREF.
- ARRIVALS page - To select arrival and approach procedures.
- HOLD page - To manage holding patterns.

Holding is described in this section but it can be used during any phase of flight.

Arrivals Page - IFR Approaches

The ARRIVALS page allows selection of an approach, standard terminal arrival route (STAR), and an arrival transition to the destination airport. This page can also be used to view data about a selected airport that is not the destination. Route 1 and route 2 have separate arrival pages.

The approaches, STARS/profile descents, and transitions are shown and selected on this page.

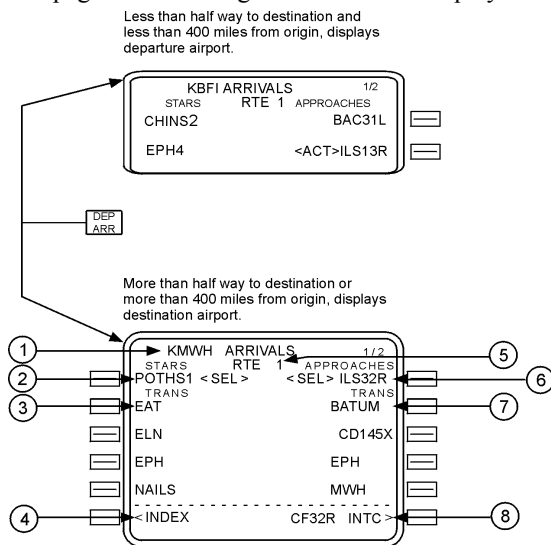
Selecting Options

Selecting a runway, approach, approach transition, STAR/profile descent, or arrival transition displays **<SEL>** inboard of the selection and displays **MOD** in the page title. The other options within the same category are removed from the list. When the modification is executed, **<SEL>** changes to **<ACT>**.

Selecting another page and returning to **ARRIVALS** displays all options; the applicable **<SEL>** or **<ACT>** prompts display.

When a STAR is selected followed by selection of an approach or runway and a transition exists in the navigation database, the transition waypoints with associated speed/altitude constraints are inserted into the flight plan linking the STAR to the approach or runway. If more than one transition exists, selection of the applicable transition is made under TRANS on the left side of the page. Some STARs serve more than one runway. If a STAR and runway are selected and subsequently a different runway is selected, and if the STAR is compatible with the new runway, the transition waypoints are inserted into the flight plan linking the STAR to the runway.

If a different STAR, runway or STAR-runway combination is desired, selecting another page and returning to the **ARRIVALS** displays all options.



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① Page Title

The destination airport identifier is shown in the title.

Airports with more than 5 runways or STARs produce multiple arrivals pages.

② Standard Terminal Arrivals (**STARS**), Profile Descents (**PROF DES**)

STARS display in a list under the **STAR** line title. Profile descents display below **STARS** under the **PROF DES** line title.

NONE displays when no **STARS** in the database.

Push –

- Selects **STAR** or **PROF DES** for entry into the route, <SEL> displays
- All other arrival procedures no longer display and transitions for the selected procedure display
- Deletes a previously selected procedure
- Displays **ERASE** prompt.

③ **STAR** Transitions (**TRANS**)

Displays list of transitions for the selected arrival procedure.

Push –

- Selects transition for entry into the route
- All other transitions no longer display.

④ **INDEX**

Push - Shows the DEP/ARR **INDEX** page.

⑤ Route 1 (**RTE 1**)

Shows the active route number (**RTE 1** or **RTE 2**).

⑥ **APPROACHES**

Displays the destination airport approaches.

Selection and execution of an ILS approach autotunes the ILS receivers and displays the course. Selection and execution of a back course (BAC) approach autotunes the ILS and displays the front course. BAC approaches cannot be flown in the MCP LOC or APP mode.

Push –

- Selects approach for entry into the route; <SEL> displays; **TRANS** replaces **RUNWAYS**
- Displays profile descents for the selected approach; deletes all other approaches and runways
- Displays **INTC** prompt for the selected approach
- Displays **ERASE** prompt.

⑦ Approach Transitions (**TRANS**)

Displays a list of transitions to the selected approach.

Approach transitions include IAF's, feeder fixes and fixes providing routing to the FAF.

When transition not selected, approach will be a straight-in approach starting at a waypoint 4 to 8 miles outside the FAF. Waypoint may be a charted fix or CFXXX (XXX is the runway number).

Push –

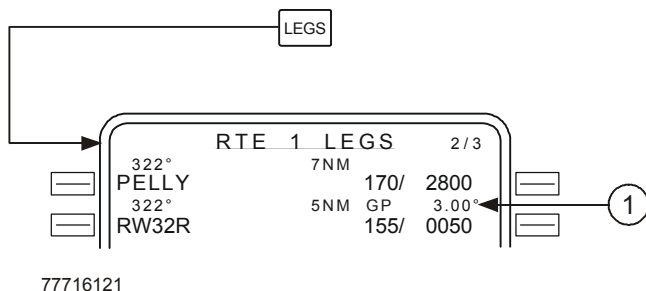
- Selects transition for entry into the route
- Deletes all other transitions
- Displays **INTC** prompt for selected transition.

⑧ Final Approach Fix Intercept (**XXXXX INTC**)

Selecting the prompt shows a modified RTE LEGS page with an intercept course to the approach transition fix (usually the IAF) for the selected approach.

ARRIVALS LEGS Page

Information added with AIMS 99 software.

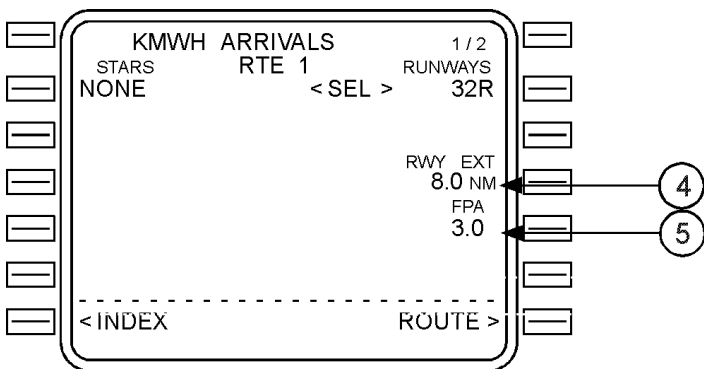
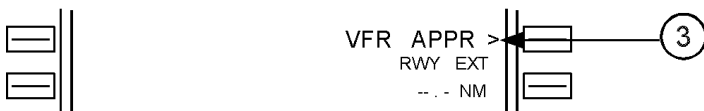
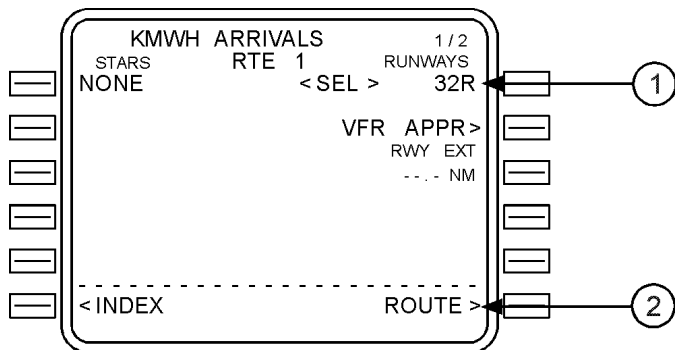


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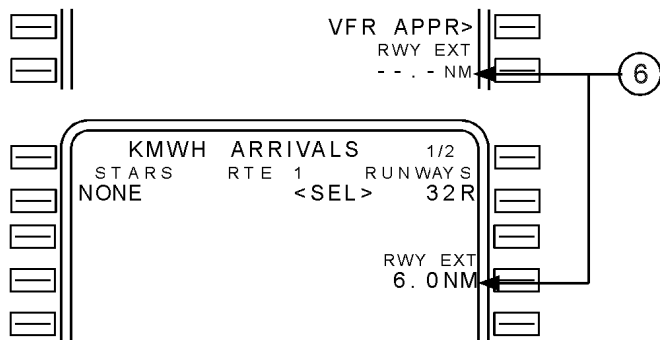
① Glide Path Display

Displays the glide path angle used by VNAV on final approach to the runway. If the runway was selected as part of a published approach, the displayed angle will be close to the published glide path angle, but may differ slightly.

Arrivals Page - VFR Approaches



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77716098

① **RUNWAYS**

Displays a list of runways for destination airport.

Push –

- Selects runway for entry into the route
- Deletes previously selected approach
- Allows selection of VFR approach or entry of **RWY EXT** data
- Deletes all other runways and approaches
- Displays approach intercept fix for selected runway.

② **ROUTE**

Push - Shows the active route page 2/X.

③ **VFR Approach (VFR APPR)** (Not operational on CAL ACFT)

Push - Makes a transition waypoint, FAXXX at 8 NM and 2000 feet above the runway.

Shown when a VFR approach is in navigation database for selected runway.

LNAV and VNAV guidance to the runway is available. VNAV programs arrival at the FAF at 170 knots.

④ **Runway Extension (RWY EXT)**

After **VFR APPR** selected, displays **RWY EXT 8.0**; **RWY EXT** can not be modified.

⑤ **Flight Path Angle (FPA)**

Shows flight path angle. Shown only after **VFR APPR** is selected.

Default is 3.0 degrees. Valid entries are from 2.4 to 3.7 degrees.

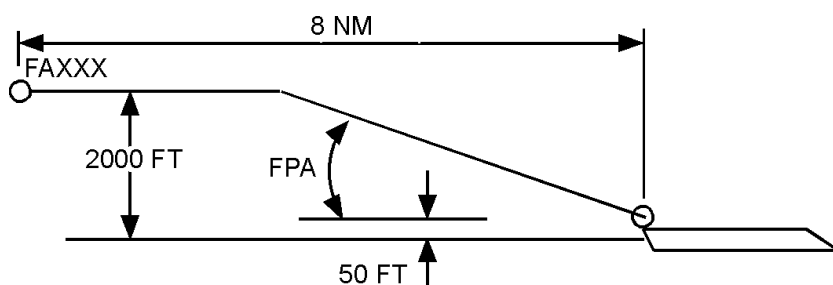
⑥ Runway Extension (RWY EXT)

Valid entries are from 1.0 to 25.0 miles from the runway threshold.

Entry allowed if **VFR APPR** is not selected. Entry removes **VFR APPR** prompt. Example shows 6 NM entered.

Makes waypoint **RXXXX**, where **YYY** is the runway; example: **RX32R**.

Makes a route discontinuity before and after the waypoint.

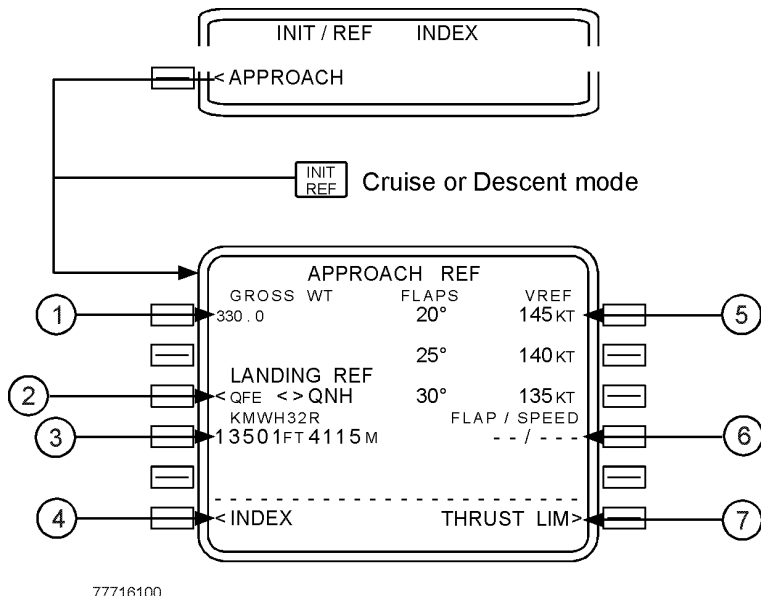
VFR Approach Path

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The VFR approach is a level path until the VNAV descent path is intercepted. The descent path begins at the FAXXX waypoint altitude and terminates at the runway threshold at 50 feet. Default values display in **RWY EXT** and **FPA**.

Approach Reference Page

The approach reference page shows approach planning data and approach reference speed (**VREF**) selection.



77716100

① Gross Weight (**GROSS WT**)

FMC calculated airplane gross weight is usually shown.

Manual entry is allowed in case the FMC calculated gross weight is unavailable or invalid, or to allow previewing recommended approach speeds at other than the calculated FMC gross weight. The manually entered gross weight will become the FMC calculated gross weight when a different page is selected and the APPROACH REF page is reselected. Permanent changes to gross weight result in recalculation of all performance data and may only be made on the PERF INIT page.

Shows boxes when gross weight is not available from the FMC.

Valid entry is XXX.X.

② Landing Reference (**LANDING REF**)

Landing reference is selectable between QNH and QFE. Usually, QNH is the operating mode.

Selecting QFE sets the cabin pressurization schedule, and the destination landing altitude indication to zero altitude. With the landing reference set to QFE, changing the barometric setting from STD to QFE changes the PFD altitude tape background color to green. With QFE selected and climb phase active, changing the barometric setting from QFE to STD causes the landing reference to toggle from QFE to QNH and the green background color is removed.

For QFE operations, refer to Supplementary Procedures, Flight Instruments, Displays.

Toggles between QFE and QNH. The active mode is shown in large green font. The inactive mode is shown in small white font.

③ Runway Length

The shown runway reference changes based on route progress. The destination runway is the reference when the present position is more than halfway to the destination or more than 400 NM from the origin airport. The origin airport runway is the reference when less than halfway or less than 400 NM from the origin airport.

Shows the length in feet and meters of the referenced runway.

④ **INDEX**

Push - Shows the INT/REF INDEX page.

⑤ **FLAPS VREF**

A gross weight is necessary for V_{REF} speed calculation. Push the applicable line select key to select the correct V_{REF} speed. The three V_{REF} speeds are based on landing flap setting.

Shows the calculated reference speed for flaps 20°, 25°, and 30°.

The display is blank until a gross weight is shown.

⑥ **FLAP/SPEED**

The flap position and V_{REF} speed is entered for landing.

The V_{REF} speed is shown on the PFD.

Deletion of the data removes V_{REF} from the PFD.

⑦ Thrust Limit (**THRUST LIM**)

Push - Shows the THRUST LIM page.

Alternate Airport Diversions

ALTN page 1/2 data helps the flight crew find the best alternate airport. The page has four airports shown in an ETA sequence. Each airport on the list has an ALTN XXXX page with more data. Select the ALTN XXXX page with a caret. ALTN LIST page 2/2 may contain a list of uplinked alternate airports.

Three alternate airport uplinks can be received. ALTN LIST page 1/2 can get an uplink for the entire page or for just the ALTN INHIB line. ALTN LIST page 2/2 can receive an uplink of alternate airport names.

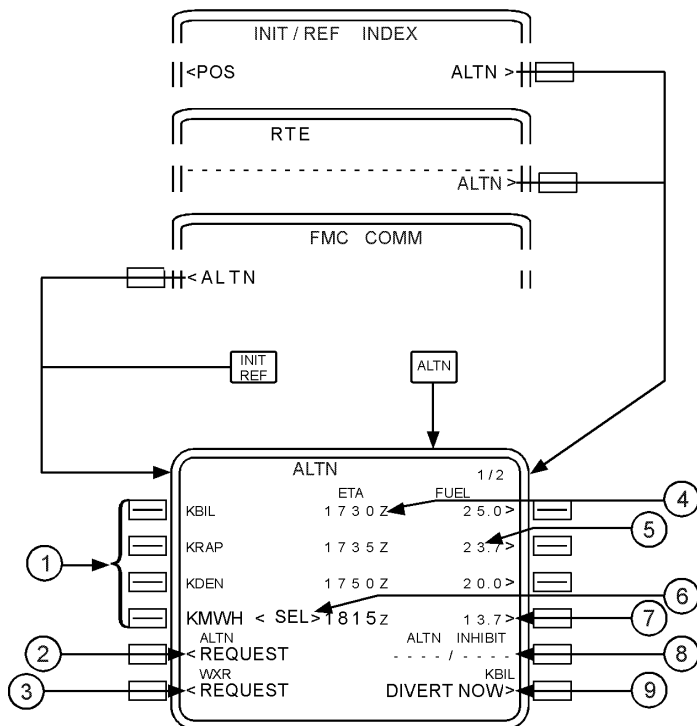
Alternate Page 1/2

The first alternate page shows alternate airport data. An alternate airport can be selected to change the flight plan destination.

The page shows a list of up to four alternate airports sorted in order of the ETA to the airport while airborne. The source of alternate airports can be:

- An uplink directly to this page
- Automatic selection from the ALTN LIST page
- Automatic selection from the navigation database
- Manual entry.

Alternate airports automatically selected from the alternate list or the navigation database are shown in a small font. All four alternates can be shown on the ND in cyan. The alternate airport symbols are automatically shown when the ND is in the plan mode. The presently selected alternate airport is shown at all times on the ND map. The other alternates are shown on the ND map display when the ARPT switch is on



77716101

① Alternate Airports

Shows the identifier of the four alternate airports in ETA order when airborne. Shows the identifier of the four alternate airports in distance order when on the ground.

A manual entry into a field displaying a small font value overwrites the small font value, but does not delete it from the Alternates Candidates list. After predictions are complete, the overwritten small font value is placed on the list according to ETA order. A manual entry into a field displaying a large font value overwrites and deletes the large font value. Manual entries display in large font.

Valid manual entry is an airport from the navigation database.

The DELETE function key can be used to remove manually entered alternate airports from the ALTN page.

② Alternate Request (**ALTN REQUEST**) (Not operational on CAL ACFT)

Push - Transmits a data link request for a preferred list of alternates (up to four).

Uplinked airports are shown in ETA order but are assigned a preference number by the transmitting site. The scratchpad shows the message **ALTN UPLINK** when the alternate airport data arrives.

③ Weather Request (**WXR REQUEST**)

Push - Transmits a data link request for alternate airport weather data.

Uplinked weather is sent to the flight deck printer.

④ **ETA**

ETA is calculated based on the routing, altitude, and speed shown on the XXXX **ALTN** page. **ETA** is blank when the airplane is on the ground.

Shows the alternate airport ETA.

Blank when airplane is on the ground.

⑤ **FUEL**

Predicted arrival fuel is calculated based on the routing, altitude, and speed shown on the XXXX **ALTN** page. The message **UNABLE FUEL** is shown in the **FUEL** column if the predicted arrival fuel is less than zero.

Fuel values are blank when the airplane is on the ground.

Shows the alternate airport predicted arrival fuel.

Blank when airplane is on the ground.

⑥ Selected (<SEL>)

The selected alternate is identified with an **<A>** or **<SEL>** to the right of the airport identifier. Usually, the closest alternate is automatically selected and identified with **<A>**. Manually selecting an alternate places **<SEL>** to the right of the airport identifier. The selected alternate identifier is shown in the line title of the **DIVERT NOW** prompt.

The FMC automatically selects the alternate airport with the earliest ETA. Automatically selected alternates show **<A>** right of the airport identifier.

A manual selection of an alternate airport is made by pushing the line select key left of the airport identifier. Manually selected alternates show **<SEL>** right of the airport identifier.

Entering a new airport into the list of four does not select the new airport.

An alternate airport can be manually selected.

Use the DELETE function key on a manually selected alternate to remove **<SEL>**. The automatic selection function selects a new alternate.

⑦ Alternate Select

Push – Displays the XXXX ALTN page for the alternate airport adjacent to the > prompt.

⑧ Alternate Inhibit (ALTN INHIBIT)

An airport will not be one of the four alternate airports if entered into the alternate inhibit line.

One or two airports can be entered.

Alternate inhibits can be manually entered or uplinked. The inhibited airports may be uplinked with the ALTN UPLINK or separately. If uplinked separately, the scratchpad shows the message **ALTN INHIBIT UPLINK**.

Valid entries are airports from the navigation database.

⑨ **DIVERT NOW**

Selecting **DIVERT NOW** displays the route from the present position to the selected alternate using the route displayed on the XXXX ALTN page for the diversion airport. The details of the route can be confirmed or modified before the diversion is executed.

Execution of the diversion:

- Changes the route destination airport.
- Includes the route modification into the active flight plan.
- Deletes all parts of the original route that are not part of the diversion.
- If a descent path exists, deletes all descent constraints (the scratchpad message **DESCENT PATH DELETED** is shown when **DIVERT NOW** is selected).

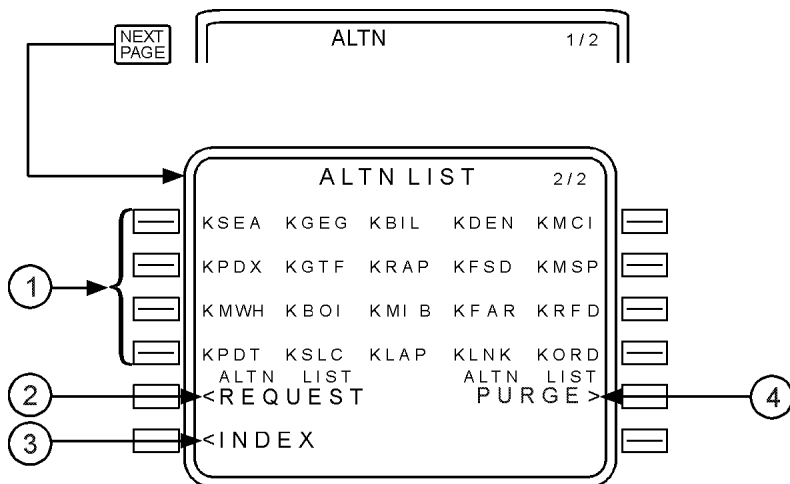
After a divert is executed the XXXX ALTN page is not updated until all CDUs are selected off of the XXXX ALTN page.

Push -

- Makes an LNAV route modification for a divert to the selected alternate.
- Automatically shows the MOD XXXX ALTN page for the selected alternate.
- The page title shows **SELECTED DIVERT**.
- Shows **SELECTED** in this position on the CDUs not involved with the modification.
- Blank on ground.
- Blank in the air when a diversion is not permitted.

Alternate List Page 2/2 (Not operational on CAL ACFT)

The second alternate page shows a list of previously uplinked alternate airports. The alternates shown on the ALTN 1/2 page are automatically selected from this list or from the navigation database when a list does not exist.



77716102

① Alternate Airports List

These four lines contain up to 20 airports from which the alternates can be selected and displayed on ALTN page 1/2 when preferred uplinked airports do not use all four lines.

The list is uplinked directly to this page. No manual entry is allowed. Manual airport entries are accomplished on the ALTN 1/2 page.

② Alternate List Request (**ALTN LIST REQUEST**)

Push - Transmits a data link request for an alternate airport list uplink.

③ **INDEX**

Push - Shows the INIT/REF INDEX page.

④ **Alternate List Purge/Confirm (ALTN LIST PURGE/CONFIRM)**

When no list exists, alternate airports can be selected from the navigation database.

Selecting the **PURGE** prompt arms the purge function and displays a **CONFIRM** prompt before the list is deleted.

Push - Deletes all airports from the list.

A new list must be uplinked after a purge.

XXXX Alternate Page

Each of the four alternate airports shown on the ALTN page 1/2 have a related XXXX ALTN page. The XXXX ALTN pages show specific data about alternate airports, the route used for a diversion, and the conditions upon which the ETA and fuel calculations are based. All data on the page is related to the alternate airport shown in the page title.

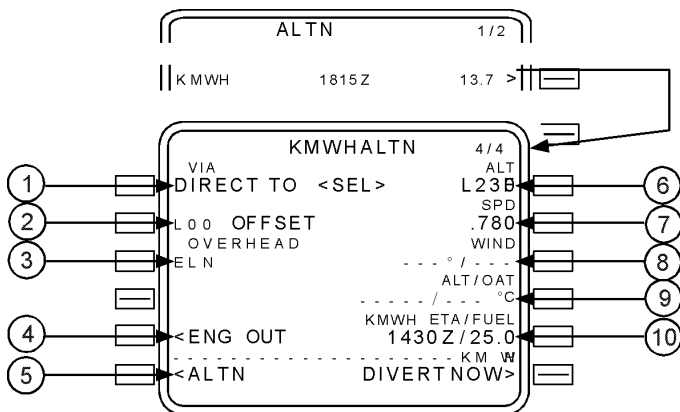
Three route options to the airport can be selected:

DIRECT TO - Direct to alternate

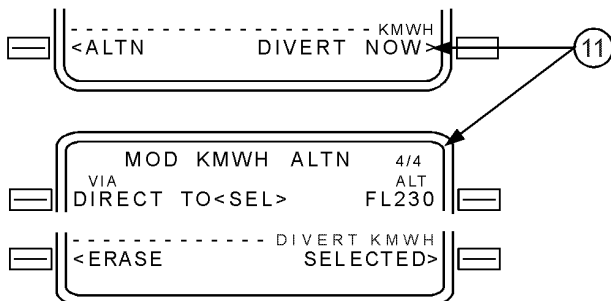
OFFSET - Flight plan route with an offset

OVERHEAD - Flight plan route to a waypoint then direct to alternate.

The selected route option has an effect on ETA and fuel remaining. It is identified by <SEL>. Selection of a route option for one alternate selects the same route option for the other three alternates.



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① **VIA DIRECT TO**

Push - Selects **DIRECT TO** route option.

All flight plan waypoints are deleted.

② **VIA OFFSET**

Push -

- With scratchpad empty, selects **OFFSET** route option
- With offset data in scratchpad, enters offset data. Does not select option.

Entry and exit to the offset is the same as for the RTE page offset. All flight plan waypoints are kept.

③ **VIA OVERHEAD**

Push -

- With scratchpad empty, selects **OVERHEAD** option.
- With overhead data in scratchpad, enters overhead data. Does not select route option.

Shows last waypoint in flight plan.

The waypoints up to the selected or entered overhead waypoint are kept, then direct to the alternate airport. All waypoints after overhead waypoint are deleted.

Enter any waypoint in the active or modified route.

④ **Engine Out (ENG OUT)**

This prompt performs the same function as described on the cruise page in the FMC Cruise section. It can be selected before or after the diversion is selected.

⑤ **Alternate (ALTN)**

Push - shows the ALTN 1/2 page.

⑥ Altitude (ALT)

Entry of any valid altitude or flight level into this line causes a recomputation of ETA and arrival fuel. Altitude entries do not become part of the diversion modification. Altitude entries apply to all four alternates.

Shows the altitude for which ETA and arrival fuel is calculated.

The scratchpad shows the message **UNABLE ALT**, if the entry is above maximum altitude or the top of climb point for divert is after top of descent point for divert.

⑦ Speed (SPD)

Entry of speed or Mach number into this line causes a recomputation of ETA and arrival fuel. Speed entries do not become part of the diversion modification. Speed entries apply to all four alternates.

Speed modes available are:

- ECON (economy)
- LRC (long range cruise)
- EO (engine out)
- EO LRC (engine out long range cruise)
- CO (company speed)
- Any CAS or Mach.

⑧ WIND

Entry of data causes a recomputation of ETA and arrival fuel. A wind entry may be made for each of the four alternates. A wind entry applies to only one alternate.

Valid entry is a direction in degrees / speed in knots from 1 to 999

⑨ Altitude / Outside Air Temperature (ALT/OAT)

Entry of data into these lines causes a recomputation of ETA and arrival fuel. A separate **ALT/OAT** entry may be made for each of the four alternates.

Shows the OAT for a specific altitude.

Valid entry is an altitude/temperature in °C.

10 Alternate Airport ETA/Fuel (**XXXX ETA/FUEL**)

Shows the calculated airport ETA and arrival fuel based on the selected route, altitude, and speed shown on this page.

11 **XXXX DIVERT NOW**

This prompt performs the same function as described on the ALTN 1/2 page.

Note: After a divert is executed, the XXXX ALTN page data is not updated until all CDUs change to a page other than the XXXX ALTN page.

HOLDING

The FMC computes holding patterns with constant radius turns based on current wind and FMC commanded airspeed. The pattern size is limited to FAA or ICAO protected airspace. In LNAV, the AFDS tracks the holding pattern using up to a 30 degree bank angle. Strong winds or airspeed in excess of FAA or ICAO entry speeds may result in the airplane flying outside the protected airspace.

With LNAV active before sequencing the holding fix, holding pattern entries are determined by the following:

- Airplane track, not heading or direction from which the active route approaches the holding pattern, determines the entry method used (parallel, teardrop, or direct entry).
- The airplane flies the initial outbound leg a computed distance from the holding fix, rather than a specific time. The computed distance is a function of the command airspeed and computed wind at the time the holding pattern becomes active.
- Teardrop entries use a 40 degree offset angle.
- Parallel and teardrop entries may cause the airplane to fly beyond the displayed holding pattern; however, the airplane remains in protected FAA or ICAO limits.

Hold Page (First Hold)

The hold page is used to enter a holding pattern into the route.

When the flight plan does not have a holding pattern, push the **HOLD** function key to show the RTE X LEGS page with the HOLD AT line.

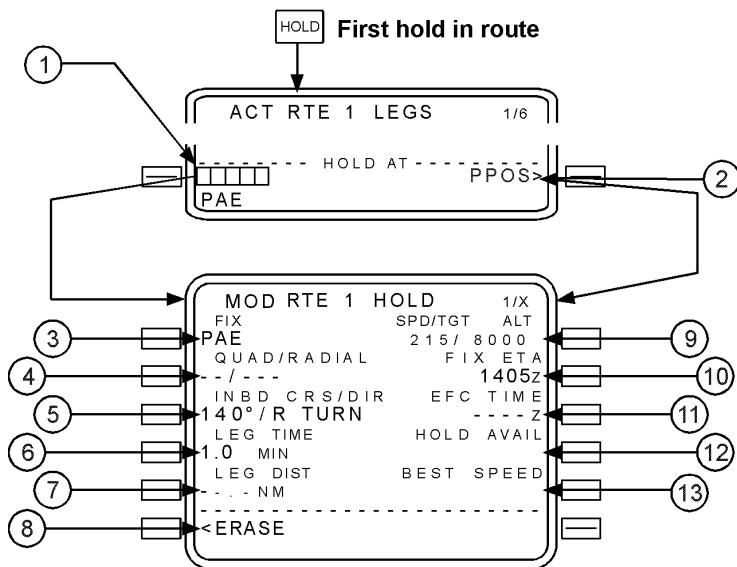
Two versions of the hold page are possible:

- An airway or procedure holding pattern.
- A flight crew-entered holding pattern.

The holding page shows actual or default data about the holding pattern.

Entries make route modifications, which can be erased or executed.

Active holding patterns are magenta on the ND.



77716105

① HOLD AT

Displays boxes to enter the holding fix: a RTE LEGS, database, or pilot-defined waypoint; a navaid or airport identifier; or a FAF already in the flight plan.

Entering a holding fix displays the RTE X HOLD page.

② HOLD AT Present Position (PPOS)

Push –

- Creates a holding pattern at present position
- Execution establishes the holding fix at the position when **EXEC** is pushed and displays **RTE HOLD**.

③ Holding FIX

Shows the holding fix.

④ Quadrant/Radial (QUAD/RADIAL)

Normally displays dashes.

Valid entry is X/XXX, XX/XXX or /XXX. Example: NW/330.

Entry changes **INBD CRS/DIR** to agree.

⑤ Inbound Course/Direction (INBD CRS/DIR)

Displays inbound course and turn direction.

Valid entry is XXX (inbound course), XXX/X (inbound course/turn direction), /X or X (turn direction).

Entry changes **QUAD/RADIAL** to agree.

Displays magenta when the holding fix is the active waypoint.

⑥ Leg Time (LEG TIME)

Displays 1.0 MIN (minute) at or below 14,000 feet.

Displays 1.5 MIN above 14,000 feet.

Displays dashes when an entry made on LEG DIST line.

Valid entry is XXX.X.

When climbing / descending through 14,000 feet with VNAV active and the **SPD/TGT ALT** at 1R displays in large font, the FMC adjusts the leg time (1.0 MIN at or below 14,000 feet; 1.5 MIN above 14,000 feet).

⑦ Leg Distance (LEG DIST)

Normally displays dashes. Allows entry of leg distance for hold.

Entry displays dashed on **LEG TIME** line.

Valid entry is XX.X or X.X.

⑧ ERASE

Erases all FMC modifications.

⑨ Speed/Target Altitude (**SPD/TGT ALT**)

Dashes display or fix speed/altitude constraint from the RTE LEGS page.

Manual entries are in large font.

During cruise, entry of a target altitude lower than CRZ ALT modifies the DESCENT page and displays a T/D. After T/D, the DESCENT page remains active unless a new cruise altitude is entered.

Speed or altitude may be entered.

⑩ **FIX ETA**

With no EFC TIME entry, displays time the aircraft will next pass the holding fix.

With EFC TIME entry, displays time the aircraft will pass the holding fix after the EFC time. The FMC uses this time to calculate downtrack ETAs and fuel values based on departing the holding fix at the new FIX ETA.

⑪ Expect Further Clearance Time (**EFC TIME**)

Enter the time expect further clearance.

Entry changes performance predictions for the route after holding.

⑫ Hold Available (**HOLD AVAIL**)

Shows calculated holding time available before requiring reserve fuel to reach the destination.

⑬ Best Speed (**BEST SPEED**)

Shows the best holding speed for the airplane gross weight, altitude, and flap setting.

Note: May exceed ICAO limit speed.

HOLD Page (Existing Hold)

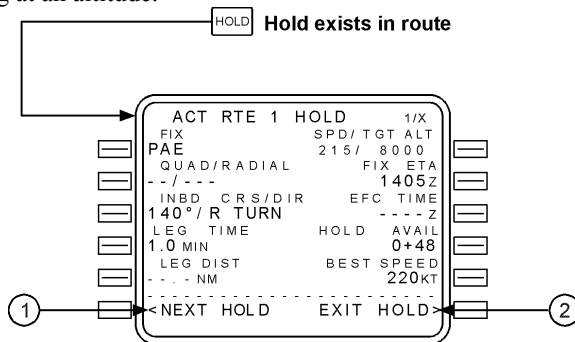
When one or more holding patterns are already in the route, push the HOLD key to show the hold page for the first holding pattern. When the hold is the next LNAV event, the active commands are shown in magenta. Holding parameters can be monitored and changed on this page. New holding patterns are added using the **NEXT HOLD** prompt.

Most holding patterns are part of a procedure or airway and remain active until the flight crew executes an exit from holding. This may be accomplished in one of two ways.

- On the ACT RTE LEGS page, deleting or bypassing the HOLD AT waypoint causes LNAV to command a direct to the next waypoint.
- On the ACT RTE HOLD page, selecting and executing EXIT HOLD> causes LNAV to command the airplane to continue in the holding pattern until arriving at the holding fix, at which time the airplane exits the holding pattern.

The FMC automatically commands an exit from some holding patterns in procedures under the following conditions.

- For instrument approach holding patterns designed as a course reversal in lieu of a procedure turn, the airplane exits holding upon arrival at the holding fix inbound.
- For some holding patterns in SIDs, the airplane exits holding when arriving at an altitude.



① **NEXT HOLD**

Push - Shows a new hold page for a new holding pattern entry.

② **EXIT HOLD**

Push -

- Arms a holding pattern exit.
- **EXIT ARMED** displays in shaded white; when executed, airplane returns to the holding fix via the inbound course for holding pattern exit.

FMS ALTERNATE NAVIGATION SYSTEM DESCRIPTION

Introduction

The CDUs can be used as an alternate navigation system if both FMCs fail. The CDUs calculate lateral navigation for the autopilot flight director system (AFDS). Pushing the LNAV switch engages the lateral steering commands. A master CDU is automatically selected. It uses ADIRU position data for navigation. VNAV is not available. Autothrottles may be available. The CDU can be used to tune the navigation radios.

During normal FMC operation, all system capabilities are contained within the FMCs. During alternate navigation operation, the CDUs use their own internal memory and computing capability. Active flight plan data from one CDU is automatically cross-loaded to the other CDUs. Modifications are shown on the CDU used for the modifications. The other CDU shows the changes after execution.

All three CDUs receive inputs from the ADIRU. Usually, the left CDU makes the left ND map and the right CDU makes the right ND map. The center CDU is automatically selected after failure of the left or right CDU.

The autopilot selects a master CDU for lateral steering commands in this order:

- Left CDU if functioning, then
- Center CDU if functioning, then
- Right CDU.

Alternate Navigation Waypoints

The CDUs do not have a performance or navigation database. The CDUs continuously copy the active route from the FMC. If both FMC's fail, the CDUs retain flight plan waypoints except for conditional waypoints, offsets and holding patterns. Waypoints on the copied route can be referenced by either their identifier, or latitude and longitude.

New waypoints can only be entered in latitude and longitude. This includes waypoints the flight crew has deleted from the copied route.

Alternate Lateral Navigation

All CDU calculations are based on a great-circle course between waypoints. The CDU does not accept undefined waypoints or conditional waypoints. Complete departure or arrival/approach procedures cannot be manually entered or cross-loaded from the FMC if they contain undefined or conditional waypoints. The CDU makes a discontinuity at those waypoints. However, individual legs of a procedure can be manually entered or cross-loaded if they constitute a great-circle course.

Route Changes

Route changes are made on the ALTERNATE NAVIGATION LEGS page in almost the same manner as normal FMC operations. All courses between waypoints are direct routes. When the active waypoint is modified, the only navigational choice is present position direct to the modified active waypoint.

A route change to any one CDU is shown on the other CDUs when the modification is executed.

Course Reference

The ADIRU supplies magnetic variation for present position. So, only the active waypoint course can be referenced to magnetic north. All subsequent waypoint courses are true courses.

Alternate Navigation Radio Tuning

The radios must be manually tuned on each CDU in alternate navigation. The left CDU tunes the left VOR, DME, ADF, and left and center ILS. The right CDU tunes the right VOR, DME, ADF, and right ILS. Manual tuning is accomplished on the ALTERNATE NAVIGATION RADIO page.

Alternate Navigation CDU Pages

The alternate navigation system operates from three CDU pages:

- ALTERNATE NAVIGATION LEGS
- ALTERNATE NAVIGATION PROGRESS
- ALTERNATE NAVIGATION RADIO.

These pages are the only ones available in the alternate navigation mode. Executed flight plan modifications made on one CDU ALTN NAV LEGS page are shown on the other CDUs.

Alternate Navigation Legs Page

This page shows data about each leg of the route. The route can be modified. Waypoint speed and altitude restrictions are not shown because performance data is not available.

Page Access

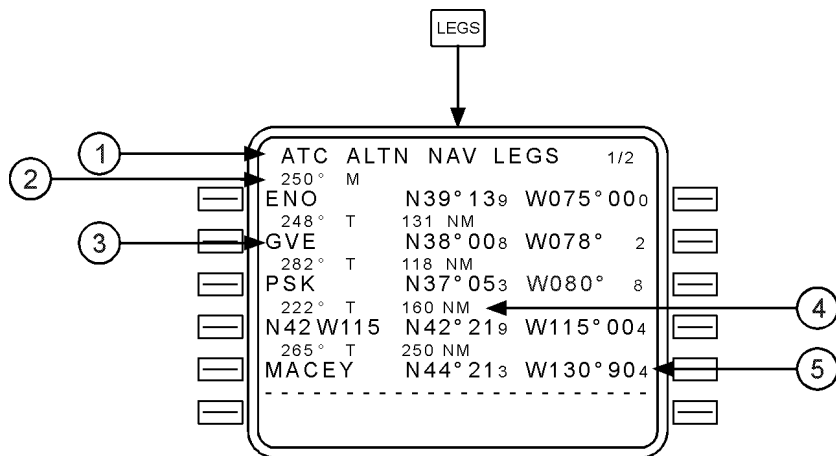
Push the LEGS function key to show the ALTN NAV LEGS page. Subsequent LEGS pages are selected with the NEXT PAGE or PREV PAGE keys.

Waypoint Operations

Waypoint operations include:

- Add new waypoints (latitude/longitude entry only).
- Remove existing waypoints.
- Change the sequence of existing waypoints.
- Connect discontinuities.

The active waypoint is shown on the first line of the first legs page in magenta. Modified waypoints are shown in shaded white until the EXEC key is pushed.



① Page Title

The page title ACT ALTN NAV LEGS is shown. If the route is modified, MOD ALTN NAV LEGS is shown until the EXEC key is pushed.

② Leg Direction

Course to the waypoint.

Course reference is **M** for magnetic, **T** for true.

Active waypoint leg direction can be magnetic or true. Subsequent waypoint leg directions are true.

③ Waypoint Identifier

Displays the waypoint by name or latitude/longitude.

Valid entries are waypoint names in the route or latitude/longitude for new waypoints.

④ Distance to Waypoint

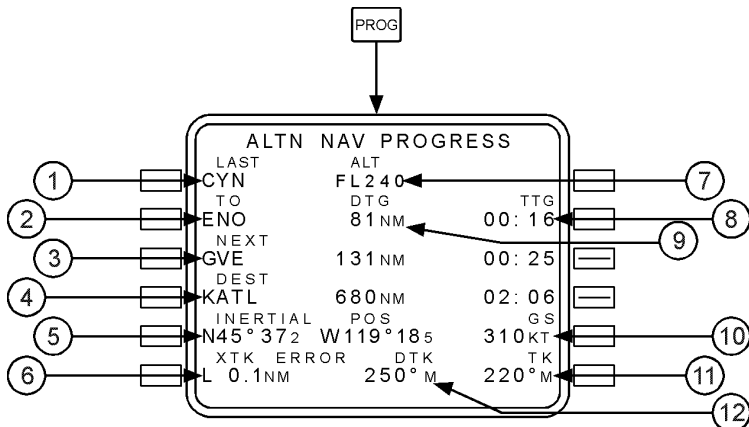
Shows the great circle distance between waypoints.

⑤ Waypoint Coordinates

Shows the waypoint coordinates.

Alternate Navigation Progress Page

This page shows general data about flight progress.



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- ① **LAST**
Shows the identifier of the last waypoint.
- ② **TO**
Shows the active waypoint on the route. The waypoint identifier is shown in magenta. This distance and time to go are shown to the right of the waypoint.
- ③ **NEXT**
Shows the waypoint after the **TO** waypoint. **NEXT** data is shown in white.
- ④ **Destination (DEST)**
The identifier for the route destination waypoint or airport. Any waypoint on or off of the route can be entered, and time and distance data is temporarily shown for that waypoint.
Display options:
 - The destination airport identifier, and distance and time to go along track to the destination airport.
 - Entry of an existing flight plan waypoint (identifier or latitude/longitude) causes the line title to change to ENROUTE WPT. Time and distance to go are from the present position direct to the new waypoint.
 - Entry of a waypoint not in the flight plan causes the line title to change to DIR TO ALTERNATE. Time and distance to go are from the present position direct to the new waypoint.

⑤ Inertial Position (**INERTIAL POS**)

ADIRU present position.

⑥ Cross Track Error (**XTK ERROR**)

Airplane left or right cross-track error in nautical miles from the active route track.

⑦ Altitude (**ALT**)

Airplane altitude when the LAST waypoint was crossed.

⑧ Time to Go (**TTG**)

Time to go to associated waypoint or destination.

⑨ Distance to Go (**DTG**)

Distance to go to associated waypoint or destination.

⑩ Ground Speed (**GS**)

ADIRU groundspeed.

⑪ Track (**TK**)

Shows the actual airplane track angle relative to the true or magnetic reference selected on the HEADING REFERENCE switch.

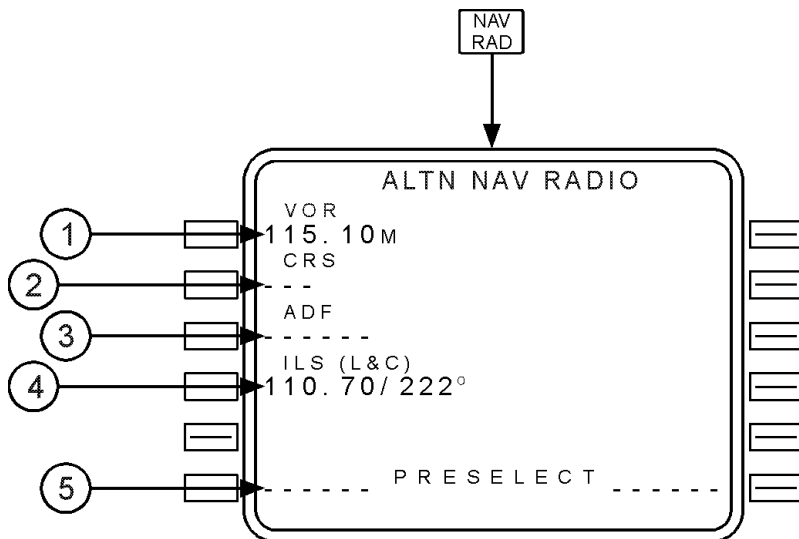
⑫ Desired Track (**DTK**)

Desired track angle relative to the true or magnetic reference selected on the HEADING REFERENCE switch.

Alternate Navigation Radio Page

Tune the navigation radios on this page. The tuned radios and associated parameters are shown. Autotune is not available. The CDUs operate independently for navigation radio tuning:

- The left CDU tunes all the left radios and the center ILS.
- The right CDU tunes all the right radios.



77716109

① VOR

Displays last selected VOR frequency. Tuning status displays as Manual (M).

Valid entry is VOR frequency or VOR frequency/course.

Entry tunes related DME frequency.

② Course (CRS)

Displays selected VOR course.

Valid entry is VOR course or VOR frequency/course.

③ ADF

Displays ADF frequency. Tuning status displays as ANT or BFO.

Displays dashes if no ADF frequency entered on NAV RAD or ALTN NAV RAD pages after initial power up.

Valid entry is ADF frequency or ADF frequency suffixed with A or B. Suffix may be changed after entry.

④ ILS

ILS frequency and/or course.

Valid entries are:

- ILS frequency
- ILS frequency/front course
- Front course only (a frequency must already be shown).

Note: If the ILS was in autotune at the time of the FMC failure, the frequency and course are automatically cross-loaded to the ALTN NAV RADIO page.

Note: The ILS frequency shows **PARK** when no frequency is tuned. Deleting the ILS frequency parks a tuned ILS.

Note: Course and frequency must be entered for the left, center, and right ILSs.

The line title is L & C on the left CDU and R on the right CDU.

DME data for the ILS is shown when the EFIS control panel ND mode selector is set to APP.

⑤ PRESELECT

Allows entry of two separate pre-selected frequencies and/or frequencies/courses. Valid entries are any of the entries that can be made on the other lines.

EICAS MESSAGES

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
ADIRU ALIGN MODE	Memo		ADIRU is in align mode.
FMC	Advisory		Both FMCs have failed or FMC selector is in L with left FMC failed or in R with right FMC failed.
FMC L, R	Advisory		Affected FMC has failed.
FMC MESSAGE	Advisory		A message is in the FMC scratchpad.
GPS	Advisory		GPS has failed.
ILS ANTENNA	Caution	Beeper	Two or more ILS receivers are not using the correct antennas for best reception.
NAV ADIRU INERTIAL	Caution	Beeper	ADIRU is not capable of providing valid attitude, position, heading, track, and groundspeed.
NAV AIR DATA SYS	Advisory		Information from the air data sources is no longer being combined for display.
NAV UNABLE RNP	Caution Advisory	Beeper	Navigation performance not meeting required accuracy. Message is a caution if fault occurs when the airplane is on approach. Message is an advisory if fault occurs when the airplane is not on approach.
TRANSPONDER L, R	Advisory		Affected transponder has failed.
SINGLE SOURCE ILS	Caution	Beeper	Both PFDs and NDs are using the same source for ILS information.

FMC Messages

FMC messages tell the flight crew when system operation is degraded or if there are data input errors. They also tell about data link status. The messages are categorized as:

- Alerting messages
- Communications messages
- Advisory messages
- Entry-error advisory messages.

The scratchpad messages are shown according to their level of importance. A less important message replaces another message in the scratchpad when the CLEAR key is pushed or the condition is corrected.

The EICAS shows the advisory message **FMC MESSAGE** when there is an FMC alerting message. The EICAS shows the message **•FMC** when there is an FMC communications message. All FMC messages illuminate the CDU message (**MSG**) light. Clear the message or correct the condition to cancel the message.

FMC Alerting Messages

FMC alerting messages:

- Are shown in the CDU scratchpad
- Cause the EICAS advisory message **FMC MESSAGE** to be shown
- Illuminate the CDU message light (**MSG**).

Use the CLEAR key or correct the condition responsible for the message to remove the message. The message is temporarily removed from the scratchpad when manually entering data. The message returns when the data is removed from the scratchpad.

ALIGNMENT REINITIATED - ADIRU alignment has automatically restarted due to airplane motion, or if the flight crew-entered initial position fails the alignment comparison tests.

CHECK ALT TGT - VNAV is selected when the airplane is between the MCP window altitude and the VNAV target altitude. VNAV holds level flight.

CHECK AIRLINE POLICY - After loading a new airline modifiable information file, the FMC determines a parameter is invalid. The FMC uses the loaded value and notifies the flight crew of the difference. This is a maintenance function.

Note: If the scratchpad message is cleared, it is not shown again for that load.

DESCENT PATH DELETED - The final altitude constraint necessary to define the descent profile is deleted.

Note: This message is shown before execution of the modification which deletes the descent path.

DISCONTINUITY - The route is not defined after the waypoint (except when the waypoint is before a manually terminated leg, such as FM, VM, HM legs).

- FM - A course from a fix to a flight crew entered manual route termination
- VM - A heading leg from a fix to a flight crew entered manual route termination
- HM - A holding pattern to a flight crew entered manual route termination.

DRAG REQUIRED - Airplane speed is too fast. Drag is required to remain on the VNAV descent path and stay within speed tolerances.

END OF OFFSET - The message is shown 2 minutes before the offset leg termination point.

END OF ROUTE - The airplane is passing the last route leg waypoint.

ENTER INERTIAL POSITION - The flight crew-entered present position did not pass one of the ADIRU comparison checks, or the ADIRU is ready to change to navigate mode and has not received a present position entry. Use the **CLEAR** key to remove this message.

FUEL DISAGREE-PROG 2/2 - Totalizer (TOTL) fuel quantity and FMC calculated (CALC) fuel quantity disagree by 9,000 pounds for more than 5 minutes.

INERTIAL/ORIGIN DISAGREE - The airplane is on the ground and one of these conditions exist:

- The inertial position entered on the POS INIT page differs from the position of the origin airport in the active route by more than 6 NM.
- A route is activated and executed containing an origin airport with a position that differs from the ADIRU inertial position by more than 6 NM.

INSUFFICIENT FUEL - Because of a change in flight conditions or the route, the calculated route fuel burn exceeds the total fuel on board, less reserves.

LIMIT ALT FLXXX - The flight crew- or FMC-selected altitude is greater than the VNAV limit altitude.

LNAV BANK ANGLE LIMITED - Before entering or while flying a curved path or holding pattern, the FMC predicts the LNAV roll command will be limited by thrust or buffet based roll limits.

NAV DATA OUT OF DATE - The clock/calendar date is after the active navigation database valid calendar cycle.

NAV INVALID/TUNE XXXX - RNAV or VOR approach procedures must have a specific navaid tuned. It is either not tuned or a valid signal is not being received.

NO ACTIVE ROUTE - The MCP LNAV switch is pushed and the FMC does not have an active lateral route.

NO ROUTE DATA - In ALTN NAV, the MCP LNAV switch is pushed and the CDU does not have an active lateral route.

PERF/VNAV UNAVAILABLE - The MCP VNAV switch is pushed and gross weight, cost index, or cruise altitude are not entered.

RESET MCP ALT - Shown 2 minutes before the top of descent point when MCP altitude is still set to airplane altitude.

RTA FIX DELETED - A modification has removed the active RTA waypoint from the flight plan.

RW/ILS CRS ERROR -

- The airplane is within ILS automatic tuning range and the tuned ILS course does not match the course for the active arrival runway, or
- The FMC is not receiving valid course data from the same ILS that the FMC is using for frequency data.
- Inhibited if scratchpad message **ILS TUNE INHIBITED-MCP** is shown.

RW/ILS FREQ ERROR -

- The airplane is within ILS automatic tuning range and the tuned ILS frequency does not match the frequency for the active arrival runway, or
- The FMC is not receiving valid frequency data from either ILS.
- Inhibited if scratchpad message **ILS TUNE INHIBITED - MCP** is shown.

SINGLE FMC L OPERATION - The right FMC is not operational.

SINGLE FMC R OPERATION - The left FMC is not operational.

TAKEOFF SPEEDS DELETED - Selected V speeds are invalid.

THRUST REQUIRED - VNAV active, autothrottle disconnected, and additional thrust required to track VNAV descent path and maintain speed.

UNABLE FLXXX AT RTA FIX - The airplane is unable to meet the required altitude at the RTA waypoint.

UNABLE RTA - The airplane is unable to meet the RTA entered on the RTA PROGRESS page.

UNABLE NEXT ALT - VNAV is not able to meet the next climb restriction altitude.

VERIFY POSITION - The FMC calculation of airplane present position is based on conflicting data. The possible conflicts are:

- The active FMC and the inactive FMC positions differ by more than twice the RNP for 5 seconds
- The difference between the FMC and the position and the aiding sensor (GPS, DME, VOR, or inertial) is greater than 12NM for 5 seconds.

VERIFY RNP - POS REF 2/3 - The default RNP has changed due to a change in flight phase and the flight crew has previously entered a different RNP value on the POS REF 2/3 page.

VIA OFFSET INVALID - Flight conditions invalidate the modification with a divert to an alternate airport via OFFSET.

FMC Communications Messages

FMC communications messages:

- Are shown in the CDU scratchpad.
- Cause the EICAS communications message **-FMC** to be shown.
- Illuminate the CDU message light (**MSG**).
- Cause the communications aural high-low chime to sound.

ALTN UPLINK - Up to four company-preferred alternate airports and associated data has been received and is available for preview on the ALTN page.

ALTN INHIBIT UPLINK - Uplink contains two airports for the ALTN page 1/2 ALTN INHIB line.

ALTN LIST UPLINK - A company list of up to 20 alternate airports has been received and is available on the ALTN LIST page.

DES FORECAST UPLINK READY - Descent forecast data has been received and is available for loading on the DESCENT FORECAST page.

FLT NUMBER UPLINK - A new flight number has been received and is available on the RTE page 1/X.

INVALID TAKEOFF XXX/YYY - Takeoff data for up to six runways or runway intersection pairs has been received but some data for one runway or runway intersection pair (RWXXX/YYY) is invalid.

PARTIAL ROUTE X UPLINK - A new route has been uplinked to the FMC but a portion of the route could not be loaded.

PERF INIT UPLINK - Performance initialization data has been received and is available for preview on the PERF INIT page.

ROUTE X UPLINK READY - A new route or route modification has been received and is available for loading on the RTE X page.

TAKEOFF DATA LOADED - An uplink that contains takeoff data matching the runway/position entry on the takeoff page is available for preview (only shown after an initial takeoff uplink has been received) or alternate thrust and/or flaps have been selected.

TAKEOFF DATA UPLINK - An uplink that contains takeoff data matching the runway on the takeoff page is available for preview.

WIND DATA UPLINK READY - Wind data has been received and is available for loading into the active route.

FMC Advisory Messages

FMC advisory messages are shown:

- On the CDU scratchpad.
- And illuminate the CDU message light (**MSG**).

DELETE - The **DELETE** key was pushed.

HOLD AT XXXX - A waypoint not contained in the active route is entered into the **HOLD AT** box on the RTE LEGS page, after selection of the **HOLD** function key. Selection of **HOLD AT XXXX** into a RTE LEGS page waypoint line makes a holding fix at the XXXX waypoint.

INVALID ALTN UPLINK - A company-preferred list of alternate airports and associated alternate data has been received but the data is not valid and can not be shown.

INVALID ALTN LIST UPLINK - A company list of up to 20 alternate airports has been received but the data is not valid and cannot be shown.

INVALID FLT NO UPLINK - A new flight number has been received but the data is not valid and cannot be shown.

INVALID FORECAST UPLINK - Descent forecast data has been received but the data is not valid and cannot be shown.

INVALID PERF INIT UPLINK - Performance initialization data has been received but the data is not valid and cannot be shown.

INVALID ROUTE UPLINK - A new flight plan route or modification to the active flight plan route has been received but the data is not valid and cannot be shown.

INVALID TAKEOFF UPLINK - Takeoff data for up to six runways or runway-intersection pairs has been received but the data is not valid and cannot be shown.

INVALID WIND DATA UPLINK - En route wind data has been received but the data is not valid and cannot be shown.

MAX ALT FLXXX - The altitude entry on any CDU page is above the performance calculated maximum altitude.

NOT ON INTERCEPT HEADING - LNAV is selected on MCP and the airplane is not within the capture criteria of active leg, or the present heading will not intercept the active leg.

STANDBY ONE - The FMC requires more than 4 seconds to show data.

TIMEOUT-RESELECT - Communication between the FMC and the CDU has failed. The flight crew must reselect **FMC** on the CDU MENU page.

UNABLE CRZ ALT - Performance predicts a zero cruise time at the entered cruise altitude.

FMC Entry Error Messages

FMC entry-error messages:

- Are shown in the CDU scratchpad.
- Illuminate the CDU message light (**MSG**).
- Push the **CLEAR** key to remove the message before any data can be entered into the scratchpad.

ARR N/A FOR RUNWAY - The runway/approach selected is not compatible with arrival selected.

CRS REVERSAL AT FA FIX - A conflict exists between the default final approach (FA) waypoint (result of a runway or VFR approach selection) and the flight plan before it.

ENG OUT SID MOD - An engine failure is sensed after takeoff before the flaps are fully retracted; the FMC has automatically loaded an available engine out standard instrument departure as a route modification to the active route.

ILS TUNE INHIBITED - MCP - ILS tuning is inhibited with the:

- Autopilot engaged.
- MCP APP switch selected.
- Localizer or glideslope captured.
- Only the flight director is engaged and either the localizer or the glideslope is captured, and the airplane is below 500 feet radio altitude.

Any attempt to manually change the ILS frequency or select another ILS approach on the CDU shows this message. To make the necessary changes:

- Above 1500 feet radio altitude - deselect approach on the MCP
 - Below 1500 feet radio altitude - select TO/GA
- or,
- Disengage the autopilot
 - Turn both flight directors OFF, and
 - Turn at least one flight director ON.

INVALID DELETE - Deletion of selected data is not allowed.

INVALID ENTRY - Attempted entry of data into the CDU field is not correctly formatted.

NOT IN DATABASE - The necessary data is not found in the route or the navigation database.

ROUTE FULL - The route is filled to the allowable capacity.

ROUTE X UPLINK LOADING - A new flight plan route or modification to the active flight plan route has been received and is being loaded after flight crew selection of the **LOAD** prompt.

RUNWAY N/A FOR SID - The selected runway is not compatible with the selected departure.

TAKEOFF FLAPS DELETED - The takeoff flap setting on the TAKEOFF REF page has been deleted by the FMC. This occurs when the THRUST REDUCTION value is changed to the same value as the takeoff flap setting.

STANDBY ONE - The FMC temporarily prevents further CDU inputs.

UNABLE TO SEND MSG - The selected data link message cannot be transmitted.

V-SPEEDS UNAVAILABLE - For certain high thrust/low gross weight takeoff conditions; FMC V-speeds are not calculated. Adjust gross weight and/or takeoff thrust limit to enable V-speed calculations.

VERIFY RNP ENTRY - The entered RNP value is greater than the default RNP value for the present flight phase or, less than the present Actual Navigation Performance.

CDU Annunciator Lights

These annunciator lights illuminate when certain conditions exist.

DSPY - A flight plan modification is pending and the RTE, RTE LEGS, RTE DATA, or RTE HOLD page not containing the active leg or route segment is shown, or a VNAV page (CLB, CRZ, or DES) not corresponding to the active VNAV mode is shown.

OFST - An offset path has been entered and executed.

MSG - An FMC message is waiting to be shown or is shown.

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14	05/01/01	47	05/01/02		
15	05/01/01	48	05/01/01	81	05/01/01
16	05/01/01	49	05/01/01	82	05/01/01
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FUEL

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FUEL SYSTEM DESCRIPTION

INTRODUCTION

The fuel system supplies fuel to the engines and the APU. The fuel is contained in a center tank, and left and right main tanks.

Refer to Section 6.7, Engines, APU, for a description of the engine and APU fuel systems.

FUEL QUANTITY

Sensors in each tank measure fuel quantity. Total fuel quantity is displayed on the primary EICAS display. Tank quantities and total fuel quantity are displayed on the FUEL synoptic display.

Expanded fuel indications showing the left main, center, and right main tank quantities are displayed when non-normal conditions occur. A **FUEL QTY LOW** EICAS message displays when either left or right main tank has 4500 lbs. or less.

FUEL TEMPERATURE

Fuel temperature is displayed on the primary EICAS display. This temperature is sensed in the left main wing tank, which is normally the coldest fuel in any of the three tanks (the right wing tank contains the right and center hydraulic cooling lines, while the left tank contains only the left hydraulic system lines and the center tank is not as susceptible to the effects of cold soaking inflight as the wings). The temperature is normally displayed in white. It is displayed in amber when the fuel temperature reaches the fuel freeze temperature value, which has been set in the MIN FUEL TEMP line on the PERF INIT page. This value should be set at 3°C degrees warmer than the freezing temperature of the fuel being used. The value is defaulted to -37°C, but can be changed by a crew or uplinked entry as required. During fuel jettison, the TO REMAIN quantity replaces the EICAS display fuel temperature indication. Fuel temperature and minimum fuel temperature are also displayed on the fuel synoptic display. The **FUEL TEMP LOW** EICAS advisory message illuminates when fuel is at or below the minimum defined temperature.

FUEL DENSITY

The density of loaded fuel is displayed on the MAINT INFO menu FUEL QTY page. The UPLIFT QUANTITY and UPLIFT DENSITY values are for the fuel that was most recently loaded. The L MAIN, CTR and R MAIN, QUANTITY and DENSITY values reflect current values for the fuel within their respective tanks.

FUEL PUMPS

Each fuel tank contains two AC-powered fuel pumps. A single pump can supply sufficient fuel to operate one engine under all conditions.

The two center tank fuel pumps are override/jettison pumps. These pumps have a higher output pressure than the left and right main tank fuel pumps. The center tank pumps override the main tank pumps so that center tank fuel is used before wing tank fuel.

If a center pump has low output pressure with more than approximately 2,400 pounds of fuel remaining, the fuel pump switch **PRESS** light illuminates and the EICAS advisory message **FUEL PUMP CENTER (L or R)** displays. If a center pump has low output pressure with less than approximately 2,400 pounds of fuel remaining, the **FUEL LOW CENTER** EICAS advisory message displays.

With the main tank pumps **ON**, a scavenge system operates automatically to transfer any remaining center tank fuel to the main tanks. Fuel transfer begins when either main tank quantity is less than 29,000 pounds.

Both center fuel pumps operate only when two electrical power sources are available. With only one power source available and the center fuel pump switches **ON**, the switch **PRESS** light on the non-powered side is illuminated and the pump pressure EICAS message is inhibited.

When the main tank fuel pump switches are off, the switch **PRESS** lights illuminate and the EICAS advisory messages **FUEL PUMP (L, R, FWD, or AFT)** display. When the center fuel pump switches are off, the switch **PRESS** lights and pump pressure EICAS messages are inhibited.

The left main tank contains a DC-powered fuel pump. It has no controls or indicators, other than the fuel synoptic display. The DC pump operates automatically to provide fuel to the APU when AC power is not available and the APU selector is **ON**.

On the ground, with the APU switch **ON** and no AC power available, the DC pump runs automatically. With AC power available, the left forward AC fuel pump operates automatically, regardless of fuel pump switch position, and the DC fuel pump turns off.

In flight, the DC fuel pump operates automatically for quick left engine relight with the loss of both engines and all AC power.

Surge tanks are provided in each wing, outboard of each main tank. Fuel in the surge tanks and fuel remaining in the refueling manifold is drained into the main tanks.

Suction Feed

When main tank fuel pump pressure is low, each engine can draw fuel from its corresponding main tank through a suction feed line that bypasses the pumps. As the aircraft climbs, dissolved air is released from the fuel in the tank due to the decrease in air pressure. This air may collect in the suction feed line and restrict fuel flow. At high altitude, thrust deterioration or engine flameout may occur as a result of the fuel flow reduction.

The dissolved air in the fuel tank will eventually deplete after reaching cruise altitude. The depletion time is dependent upon aircraft altitude, fuel temperature, and type of fuel. Once the dissolved air is depleted, the engine should effectively operate on suction feed.

Fuel pressure can be provided from a main tank with operating fuel pumps to both engines by opening the fuel crossfeed valve(s). Continued crossfeed use will result in a progressive fuel imbalance.

FUEL CROSSFEED

The fuel manifolds are arranged so that any fuel tank pump can supply either engine. The crossfeed valves are closed during normal operations. The closed crossfeed valves isolate the left and right systems. Either valve can be opened to feed an engine from the opposite fuel tank. If the valve position does not agree with the switch position, the **CROSSFEED SWITCH VALVE** light illuminates and the EICAS advisory message **FUEL CROSSFEED FWD** or **AFT** displays.

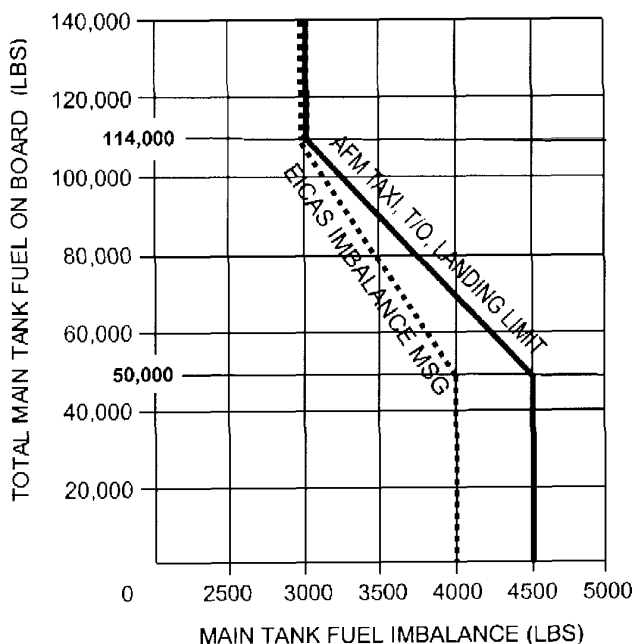
FUEL IMBALANCE

The EICAS advisory message **FUEL IMBALANCE** displays 30 seconds after the difference in sensed fuel quantity between the left and right main tanks becomes excessive. The imbalance value that triggers the EICAS message varies in relation to total fuel on board in the main tanks, from 3000 lbs imbalance at 114,000 lbs or greater total main tank fuel, to 4000 lbs imbalance at 50,000 lbs or less total main tank fuel. The AFM imbalance limit for taxi, takeoff, and landing varies from 3000 lbs imbalance at 114,000 lbs or greater total main tank fuel, to 4500 lbs imbalance at 50,000 lbs or less total main tank fuel (see following diagram). These limits are established to preclude negative long term effects on aircraft structure and to comply with aircraft FAR imbalance limits. There is, however, sufficient lateral control available to safely land the aircraft with the equivalent imbalance of one main tank full and the other empty. Exceedence of these imbalance limits during taxi, takeoff, flight or landing does not require a logbook entry or any aircraft inspection procedure.

Fuel balancing is accomplished by opening one or both crossfeed valves and turning off the fuel pump switches for the fuel tank that has the lowest quantity. Fuel balancing may be accomplished in any phase of flight, and the crossfeed valve may be open during landing.

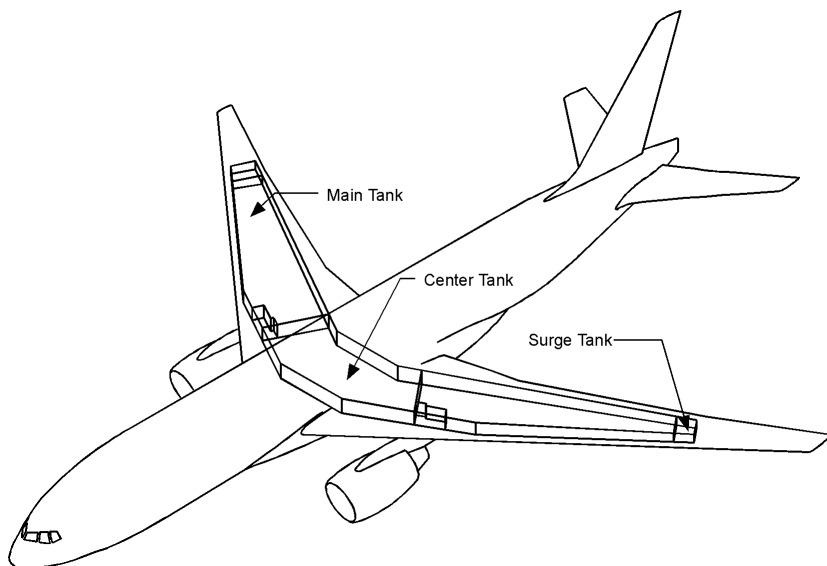
FUEL IMBALANCE LIMITS

MAIN TANK FUEL IMBALANCE INFORMATION



FUEL TANK LOCATIONS AND CAPACITIES

Fuel Tank Locations

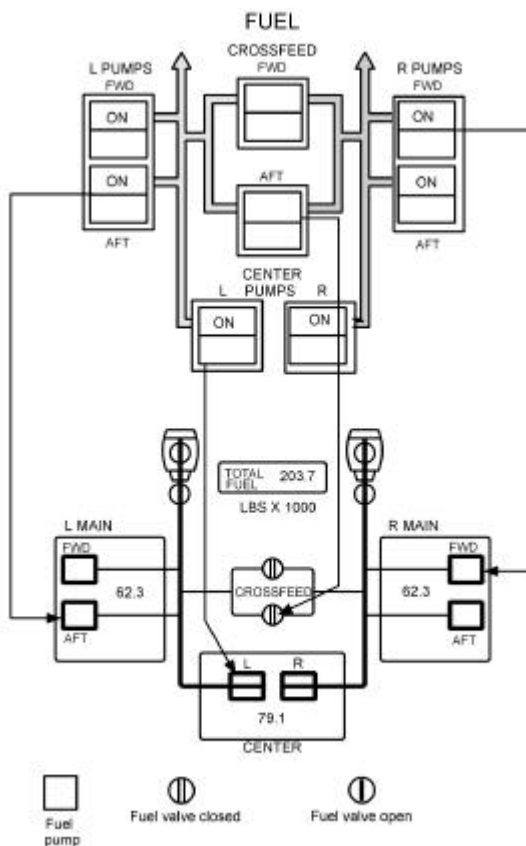


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Fuel Tank Capacities

Tank	Gallons	Pounds *
Left Main	9,560	64,100
Right Main	9,560	64,100
Center	26,100	174,900
Total	45,220	303,100
*Usable fuel at level attitude, fuel density = 6.7 pounds per US gallon.		

FUEL SYSTEM SCHEMATIC



7771702

APU FUEL FEED

APU fuel is supplied from the left fuel manifold. APU fuel can be provided by any AC fuel pump supplying fuel to the left fuel manifold or by the left main tank DC fuel pump.

FUEL JETTISON

The fuel jettison system allows jettison from all fuel tanks. Fuel is jettisoned through jettison nozzle valves inboard of each aileron. Additional jettison pumps in the main tanks and the override/jettison pumps in the center tank pump fuel overboard through the jettison nozzle valves.

Fuel jettison is initiated by pushing the FUEL JETTISON ARM switch to select ARMED. The jettison system automatically sets the fuel-to-remain to the maximum landing weight (MLW) fuel quantity. The TO REMAIN quantity replaces fuel temperature on the EICAS display.

Pull on and rotate the FUEL TO REMAIN selector to manually decrease or increase the TO REMAIN quantity.

Main tank jettison begins when the fuel jettison nozzle switches are pushed ON:

- The jettison nozzle valves open
- The center tank jettison isolation valves open, and
- The main tank jettison pumps operate.

If the center tank override/jettison pumps are on, center tank fuel also jettisons. Center tank fuel will not jettison if the center tank override/jettison pumps are off.

The nozzles cannot open on the ground, regardless of switch positions.

In flight, jettison time is displayed in minutes on the fuel synoptic when the jettison arm switch is positioned on while in the air. Jettison automatically stops when the TO REMAIN quantity is reached. The system shuts off the main tank jettison pumps and closes the center tank jettison isolation valves.

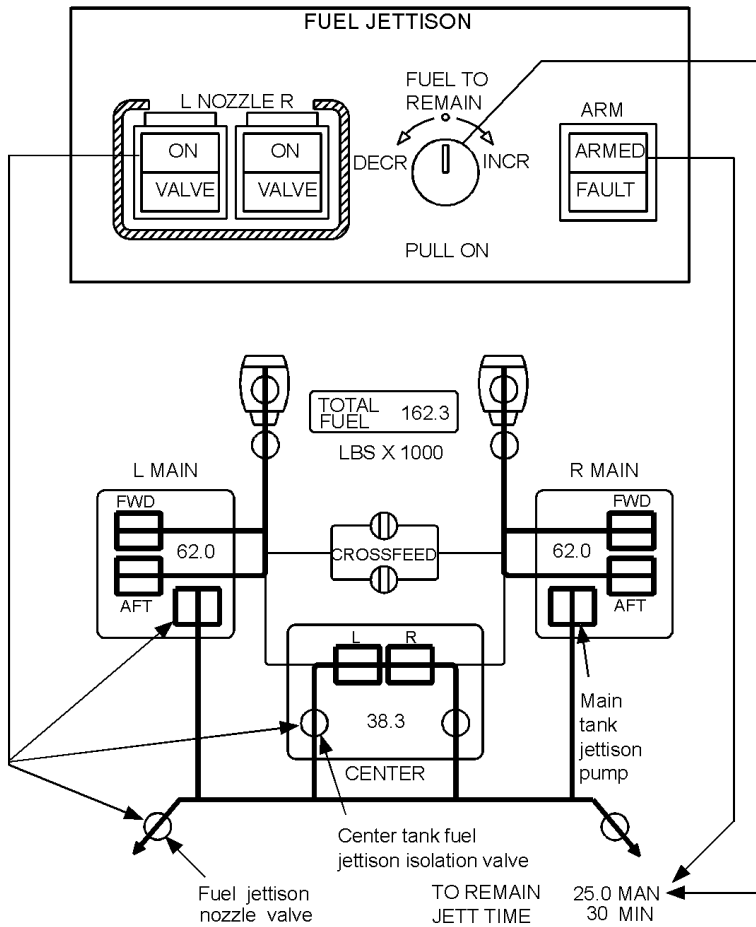
Fuel quantity indication will not be accurate immediately after fuel jettison is terminated. A one-minute delay filter exists as part of the jettison system. This means that fuel jettison quantity requested will only be accurate after at least a one-minute after fuel jettison is terminated.

When the airplane is heavy and loaded near the forward CG, fuel is jettisoned from the center tank first to keep CG within limits; main tank jettison pump operation is delayed. The computed jettison time is automatically adjusted to reflect the increased jettison time.

At least 11,500 pounds of fuel remains in each main tank after jettison is complete. All center tank fuel may be jettisoned.

Jettison rate is approximately 5400 lbs/min (4 pumps) from the center and main tanks. With the center tank empty the jettison rate for main tanks is approximately 3100 lbs/min (2 main tank jettison pumps). The jettison rate is also approximately 3100 lbs/min (2 center tank pumps) when the aircraft is loaded near the forward CG, and main tank jettison pump operation is delayed.

Fuel Jettison Schematic



FUEL SYSTEM FMS CDU MESSAGES

The CDU can display the following messages.

FUEL DISAGREE-PROG 2/2 - The fuel totalizer and calculated fuel quantity disagree.

INSUFFICIENT FUEL - Predicted fuel at destination is less than reserves.

FUEL

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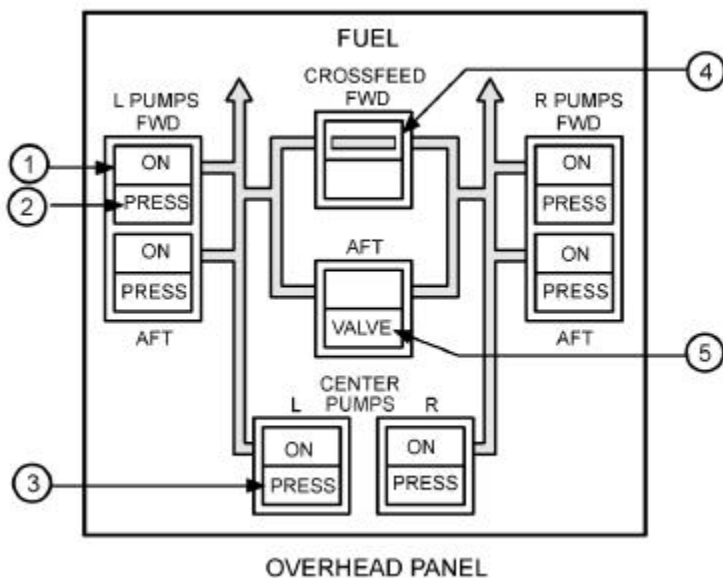
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CONTROLS AND INDICATORS

FUEL SYSTEM



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- ① Fuel Pump Switches
 - ON - The fuel pump is selected ON.
 - Off (ON not visible) - The fuel pump is selected off.
- ② Forward and Aft Fuel Pump Pressure (**PRESS**) Lights
 - Illuminated (amber) - Fuel pump output pressure is low.
- ③ Center Fuel Pump Pressure (**PRESS**) Lights
 - Illuminated (amber) -
 - Fuel pump output pressure is low with the pump selected ON
 - Illumination is inhibited when the center tank fuel pump switch is selected off.

④ CROSSFEED Switches

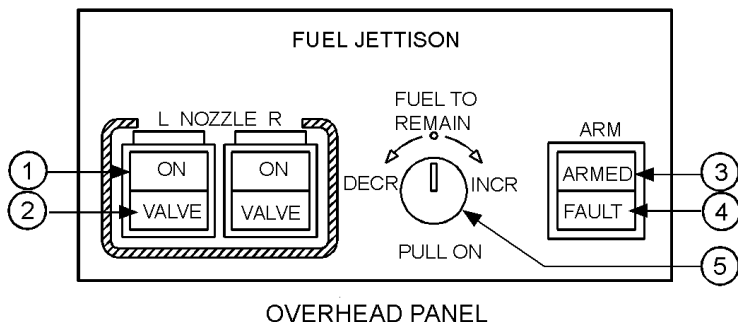
On (bar visible) - The crossfeed valve is selected open.

Off (bar not visible) - The crossfeed valve is selected closed.

⑤ Crossfeed **VALVE** Lights

Illuminated (amber) - The crossfeed valve is not in the selected position.

FUEL JETTISON SYSTEM



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① Fuel Jettison NOZZLE Switches

ON -

- The jettison nozzle valve is selected open in flight
- If in flight and jettison is armed, turns on both main tank jettison pumps and opens both center tank jettison isolation valves.

Off (ON not visible) - The jettison nozzle valve is selected closed.

② Fuel Jettison Nozzle **VALVE** Lights

Illuminated (amber) - The jettison nozzle valve is not in the selected position.

③ Fuel Jettison ARM Switch

ARMED -

- Arms the jettison system
- Initializes fuel-to-remain at the MLW fuel quantity.

Off (ARMED not visible) - Disarms the jettison system.

④ Fuel Jettison **FAULT** Light

Illuminated (amber) -

- A system fault has occurred
- Fuel jettison is inoperative.

⑤ FUEL TO REMAIN Selector

PULL ON- changes the mode from MLW (maximum landing weight) to MAN (manual)

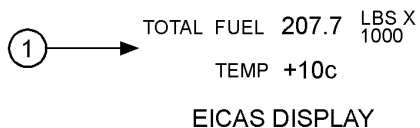
Rotate -

- Rotate CW to increase, CCW to decrease the MANUAL fuel-to-remain quantity
- Sets the manual (MAN) fuel-to-remain quantity selection at the slow rate (first detent) or fast rate (second detent).

Push - automatically selects the MLW fuel-to-remain quantity.

FUEL INDICATIONS

Normal Fuel Indications



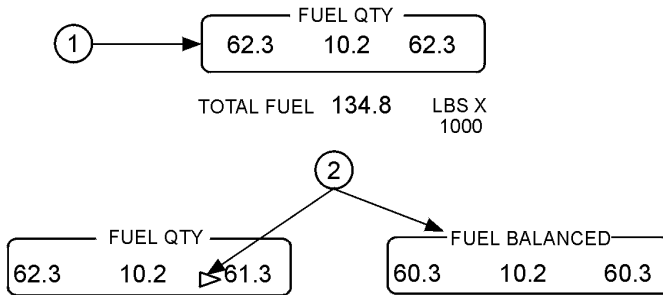
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① Normal Fuel Indications

Total fuel quantity (pounds x 1000).

Fuel temperature (degrees Celsius).

Expanded Fuel Indications



EICAS DISPLAY

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① Expanded Fuel Indications

The expanded **FUEL QUANTITY** display (left main, center, and right main tank quantities) appears for any of the following conditions:

- One or both crossfeed valves open
- One or more fuel tank quantity indications are inoperative
- The **FUEL IN CENTER** alert message is displayed (center tank quantity is amber)
- The **FUEL QTY LOW** alert message is displayed (low main tank quantity is amber)
- The **FUEL IMBALANCE** alert message is displayed.

② Fuel Imbalance Indications

A fuel imbalance pointer is displayed on the expanded fuel quantity display next to the low tank quantity for the following imbalance conditions.

A solid white pointer is displayed if:

- Main tank fuel differs more than 1000 pounds
- Main tank fuel differs more than 200 pounds and a crossfeed valve is open.

A solid amber fuel imbalance pointer replaces the white pointer if the **FUEL IMBALANCE** message is displayed. The difference in fuel quantity which causes the **FUEL IMBALANCE** message to be displayed varies with total main tank fuel quantity.

The fuel imbalance pointer flashes if fuel balancing is going in the wrong direction.

When fuel is back in balance within 200 pounds between the main tanks - **FUEL BALANCED** replaces **FUEL QTY** on the expanded fuel quantity display and flashes for 5 seconds.

Fuel Jettison Indications

TOTAL FUEL	207.7	LBS X
TO REMAIN	25.0	$\frac{1000}{\text{MLW}}$

← (1)

EICAS DISPLAY

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① Fuel Jettison Indications

Fuel to remain (fuel jettison ARMED):

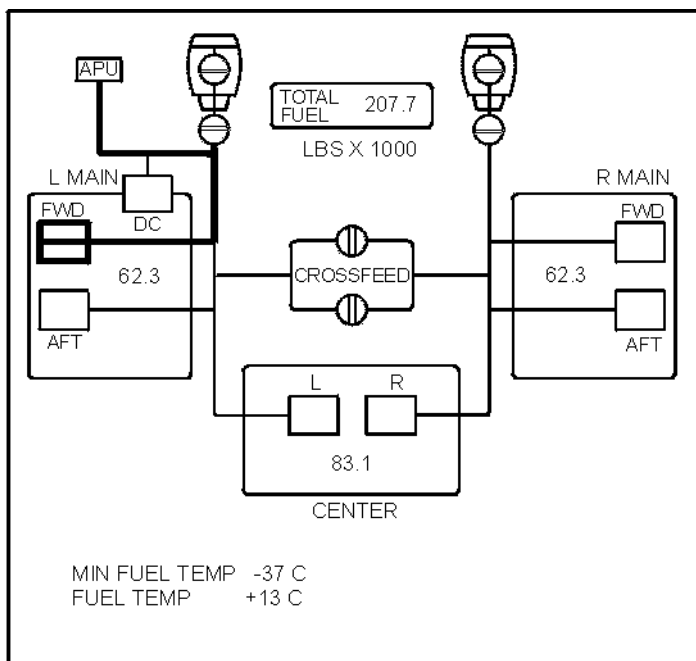
- The fuel to remain defaults to a fuel quantity that will leave the airplane at maximum landing weight (MLW) when jettison is complete
- The fuel to remain display replaces the fuel temperature display.

Fuel to remain **MAN** (manual) selection is displayed:

- Fuel jettison system is ARMED
- The FUEL TO REMAIN selector is pulled on
- The quantity to remain can be changed by rotating the FUEL TO REMAIN selector to the slow or fast rate position.

FUEL SYNOPSIS DISPLAY

The fuel synopsis is displayed by pushing the FUEL synopsis display switch on the display select panel. Display select panel operation is described in Section 6.10, Flight Instruments, Displays.



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MULTIFUNCTION DISPLAY

FUEL SYSTEM EICAS MESSAGES

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
FUEL AUTO JETTISON	Caution	Beeper	Fuel jettison automatic shutoff has failed, or total fuel quantity is less than selected TO REMAIN quantity and a nozzle valve is open.
FUEL CROSSFEED AFT, FWD	Advisory		Crossfeed valve is not in the commanded position.
FUEL IMBALANCE	Advisory		Fuel imbalance between the main tanks is excessive.
FUEL IN CENTER	Advisory		Both center fuel pump switches are OFF with fuel in the center tank.
FUEL JETT NOZZLE L, R	Advisory		Jettison nozzle valve is not in the commanded position.
FUEL JETTISON MAIN	Advisory		Fuel jettison from the main tanks is inoperative.
FUEL JETTISON SYS	Caution	Beeper	Fuel jettison system is inoperative.
FUEL LOW CENTER	Advisory		Center tank is empty and one or both center fuel pump switches are ON.
FUEL PRESS ENG L, R	Caution	Beeper	Engine is on suction feed.
FUEL PRESS ENG L+R	Advisory		All fuel pump output pressures are low.
FUEL PUMP CENTER L, R	Advisory		Center fuel pump output pressure is low.
FUEL PUMP L AFT, FWD	Advisory		Left aft or forward fuel pump output pressure is low.
FUEL PUMP R AFT, FWD	Advisory		Right aft or forward fuel pump output pressure is low.
FUEL QTY LOW	Caution	Beeper	Fuel quantity is 4500 lbs or less in either left or right main tank.
FUEL TEMP LOW	Advisory		Fuel temperature is approaching freezing.
FUEL VALVE APU	Advisory		APU fuel valve is not in the commanded position.

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HYDRAULIC SYSTEM DESCRIPTION

INTRODUCTION

The airplane has three independent hydraulic systems: left, right, and center. The hydraulic systems power the:

- Flight controls
- Leading edge slats
- Trailing edge flaps
- Landing gear
- Wheel brakes
- Nose and main gear steering
- Thrust reversers.

Flight control system components are distributed so that any one hydraulic system can provide adequate airplane controllability.

Hydraulic fluid is supplied to each hydraulic pump from the associated system reservoir. The reservoirs are pressurized by the bleed air system.

LEFT AND RIGHT HYDRAULIC SYSTEMS

The left and right hydraulic systems are identical. They differ only in the components they power.

The left hydraulic system powers:

- Flight controls
- The left engine thrust reverser.

The right hydraulic system powers:

- Flight controls
- Normal brakes
- The right thrust reverser.

LEFT AND RIGHT HYDRAULIC SYSTEM PRIMARY PUMPS

The left and right hydraulic systems each have a primary pump. The left and right primary pumps are engine-driven by the related left and right engines.

LEFT AND RIGHT HYDRAULIC SYSTEM DEMAND PUMPS

The left and right hydraulic systems each have a demand pump. The demand pumps are electric motor-driven. The demand pumps provide supplementary hydraulic power for periods of high system demand. The demand pumps also provide a backup hydraulic power source for the engine-driven primary pumps.

The pumps are controlled by the DEMAND L and R pump selectors. In the AUTO position, the L and R demand pumps operate for takeoff, landing, and when system or primary pump pressure is low. In the ON position, the demand pump runs continuously.

Note: In the AUTO position the right demand pump operates continuously when the airplane is on the ground.

Center Hydraulic System

The center hydraulic system powers:

- Flight controls
- Alternate brakes
- Leading edge slats
- Reserve brakes
- Trailing edge flaps
- Nose gear steering
- Landing gear actuation
- Main gear steering.

The Ram Air Turbine (RAT) can provide hydraulic power to the center hydraulic system primary flight control components only.

Center Hydraulic System Primary Pumps

Two electric motor-driven primary pumps are the primary hydraulic power sources for the center hydraulic system. The PRIMARY C1 and C2 pump switches control pump operation. The PRIMARY C1 pump gets hydraulic fluid from the bottom of the center system reservoir. All other pumps in the center system get fluid via a standpipe in the reservoir. This provides the PRIMARY C1 pump with a 1.2 gallon reserve supply of hydraulic fluid. The PRIMARY C2 pump may be load shed by the electrical load management system.

On the ground:

With only a single external power source, or the APU only, the PRIMARY C2 pump will not run if the PRIMARY C1 pump is selected. The PRIMARY C2 pump will not be load shed if one engine generator is operating.

In flight:

The PRIMARY C2 pump may be load shed by the electrical load management system when the following conditions exist:

- All other electric pumps are running.
- There is a single source of electrical power.
- Generator capacity is exceeded.

Center Hydraulic System Demand Pumps

The center hydraulic system has two air-driven demand pumps. The demand pumps provide supplementary hydraulic power for periods of high system demand. The demand pumps also provide a backup hydraulic power source for the center system electric motor-driven primary pumps.

The pumps are controlled by the DEMAND C1 and C2 pump selectors. In the AUTO position, the demand pumps operate when system or primary pump pressure is low, or when system logic anticipates a large demand. In the ON position, the demand pump runs continuously. Selecting both demand pumps ON results in only the DEMAND C1 pump operating. Both pumps cannot operate simultaneously when ON is selected for both pumps.

Center Hydraulic System Non-Normal Operation

The PRIMARY C1 hydraulic pump and reserve fluid are dedicated to operating reserve brakes, nose gear actuation, and nose gear steering.

If center hydraulic system quantity is sensed to be low and airspeed is greater than 60 knots, the following automatic isolations occur:

- Reserve brakes are isolated from the center system and remain operable.
- Nose gear actuation and steering are further isolated and are inoperable.

Nose gear actuation and steering are reconnected when:

- Airspeed decreases below 60 knots (e.g. RTO), or
- Hydraulic pressure to the center system flight controls goes low, or
- The landing gear is selected down, both engines are normal, and both engine-driven pumps are providing pressure.

RAM AIR TURBINE (RAT)

The RAT, when deployed, provides hydraulic power only to the primary flight control components connected to the center hydraulic system. The RAT provides hydraulic and electrical power throughout the flight envelope.

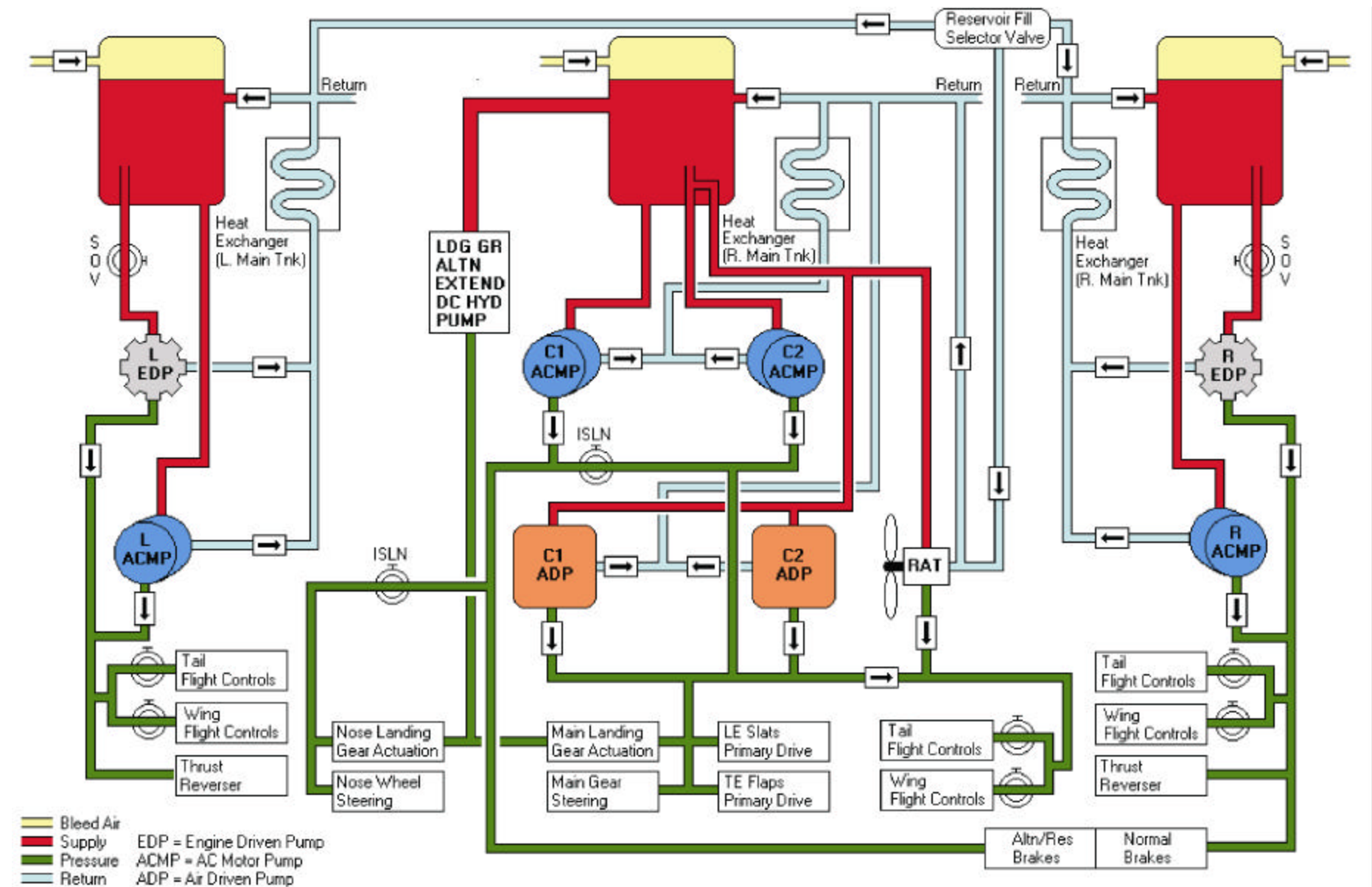
The RAT can supply electrical and hydraulic power simultaneously. If the RAT is unable to maintain RPM, the RAT's generator electrical load is shed until RPM is satisfactory. The RAT has a priority to provide hydraulic power to flight controls over power to the C1 and C2 TRUs. In flight, the RAT deploys automatically if:

- Both engines are failed and center system pressure is low, or
- Both AC transfer busses are unpowered, or
- All three hydraulic system pressures are low.

The RAT can be deployed manually by pushing the RAM AIR TURBINE switch. The hot battery or APU battery bus must be powered. The center hydraulic system does not need to be powered. The RAT is deployed by a compressed spring. Once deployed, the RAT cannot be stowed in flight.

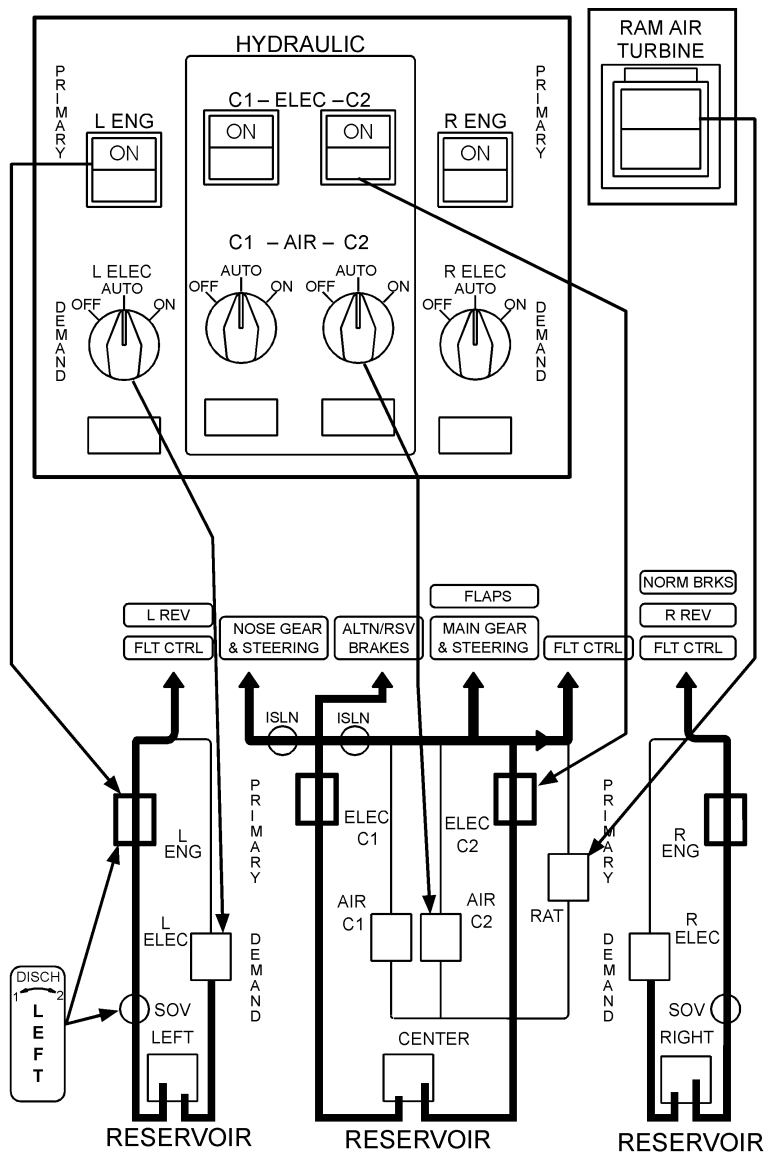
Warning: The RAT can be manually deployed on the ground. Deployment could cause serious injury to ground personnel or damage ground equipment.

Hydraulic Systems Schematic

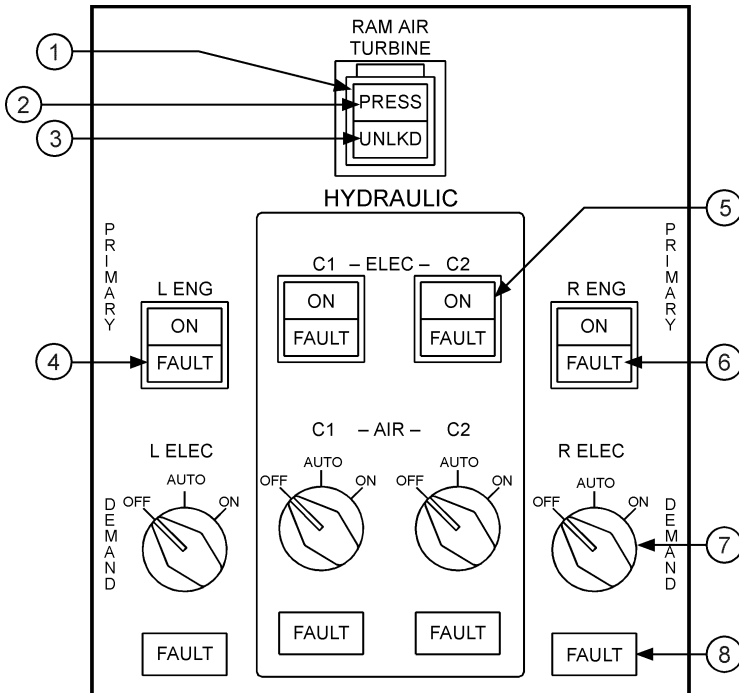


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HYDRAULIC CONTROLS AND INDICATORS



HYDRAULIC PANEL



OVERHEAD PANEL

7771802

- ① RAM AIR TURBINE Switch
Push - Deploys the RAT.
- ② Ram Air Turbine Pressure (**PRESS**) Light
Illuminated (green) -
 - The RAT is deployed
 - Center system primary flight control hydraulic pressure is greater than 1500 psi.
- ③ Ram Air Turbine Unlocked (**UNLKD**) Light
Illuminated (amber) - The RAT is not in the stowed position.

④ Left/Right Engine (L/R ENG) PRIMARY Pump Switches

ON - The engine-driven hydraulic pump pressurizes the related left or right hydraulic system when the engine rotates.

Off (ON not visible) - The engine-driven hydraulic pump is turned off and depressurized.

⑤ C1/C2 Electrical (C1/C2 ELEC) PRIMARY Pump Switches

ON -

- The electric motor-driven hydraulic pump operates
- Pressurizes the center hydraulic system.

Off (ON not visible) - The electric motor-driven hydraulic pump off is turned off.

⑥ Primary Pump **FAULT** Lights

Illuminated (amber) -

- Low primary pump pressure
- Excessive primary pump fluid temperature, or
- Pump selected OFF.

⑦ DEMAND Pump Selectors

ON - the pump runs continuously.

AUTO - the pump operates when system and/or primary pump(s) pressure is low, or when control logic anticipates a large system demand.

OFF - the pump is off.

Note: If both air-driven pumps are selected to ON, only air-driven pump C1 operates; the two air-driven pumps cannot operate simultaneously when both are selected ON.

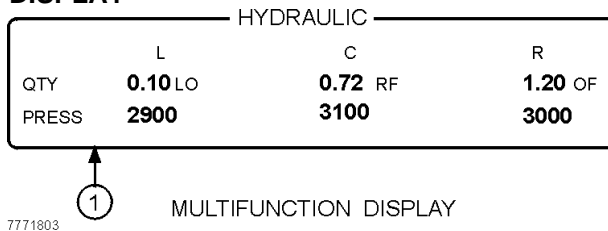
⑧ Demand Pump **FAULT** Lights

Illuminated (amber) -

- Low demand pump output pressure
- Excessive demand pump fluid temperature, or
- Demand pump is selected OFF.

HYDRAULIC SYSTEM INDICATIONS

To view the status display, push the STAT display switch on the display select panel. To view the hydraulic synoptic, push the HYD synoptic display switch on the display select panel. Display select panel operation is described in Section 6.10, Flight Instruments, Displays.

STATUS DISPLAY

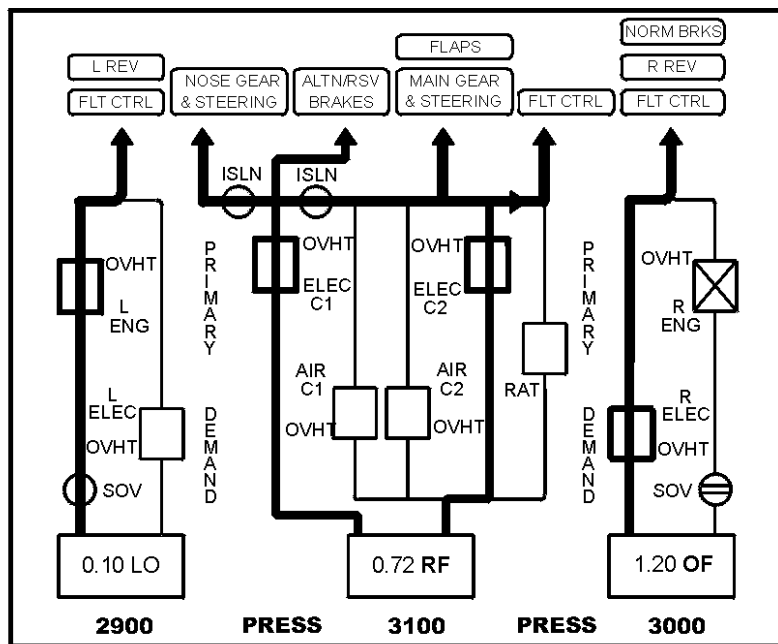
① Hydraulic Display

QTY -

- Displays system reservoir quantity as a percentage of the normal service level (1.00 is the normal service level)
- LO (amber) - Displayed when the reservoir quantity is low
- OF (white) - Displayed when the reservoir is over-full (ground only)
- RF (white) - Displayed when the reservoir requires refilling (ground only).



PRESSURE - Displays hydraulic pressure in pounds per square inch of the pump with the highest pressure.

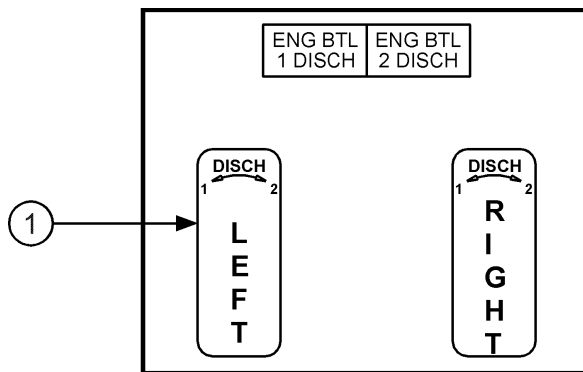
Hydraulic Synoptic Display



MULTIFUNCTION DISPLAY

AIR – air-driven pump
ELEC – electric-driven pump
ENG – engine-driven pump
ISLN – isolation valve
LO – reservoir quantity low
OF – reservoir quantity over-full
OVHT – pump overheat indication

RAT – ram air turbine pump
RF – reservoir requires refilling
SOV – shutoff valve
Closed valve – 
Failed pump – 

MISCELLANEOUS HYDRAULIC SYSTEM CONTROLS

AFT AISLE STAND

7771805

Engine Fire Panel

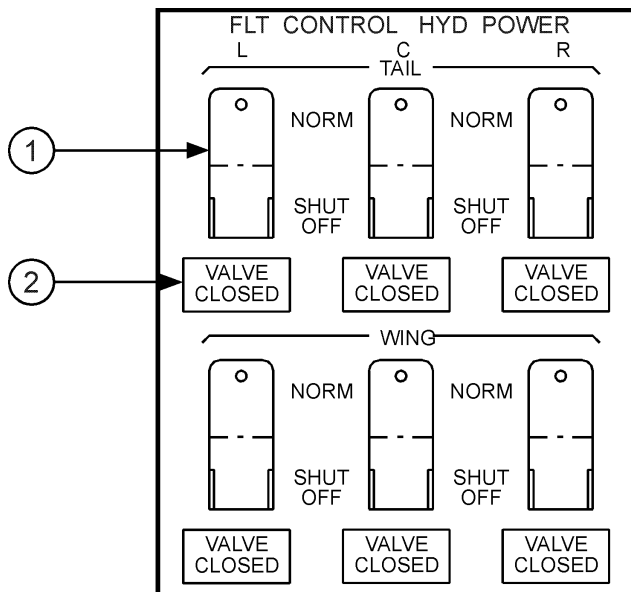
① Engine Fire Switches

Pull -

- Closes the engine-driven pump hydraulic shutoff valve
- Depressurizes the engine-driven pump.

FLIGHT CONTROL HYDRAULIC POWER SWITCHES

Note: No flight crew normal or non-normal procedures require operation of the flight control shutoff switches. These switches are for ground maintenance use only.



OVERHEAD MAINTENANCE PANEL

7771806

① Flight Control Hydraulic Power Shutoff Switches

NORM - Hydraulic system power is available to the flight control actuators.

SHUT OFF - Hydraulic system power to the flight control actuators is shut off.

Note: In flight, the center system flight control shut off valves are isolated from electrical power and cannot be closed.

② Flight Control Hydraulic Power **VALVE CLOSED** Lights

Illuminated (amber) - The related valve is closed.

HYDRAULICS, RAM AIR TURBINE EICAS MESSAGES

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
HYD AUTO CONTROL C	Advisory		Both center demand pump AUTO functions and all center hydraulic system indications are inoperative.
HYD AUTO CONTROL L, R	Advisory		Demand pump AUTO function and all left or right system indications are inoperative.
HYD OVERHEAT DEM C1, C2, L, R	Advisory		Demand pump temperature is high.
HYD OVERHEAT PRI C1, C2, L, R	Advisory		Primary pump temperature is high.
HYD PRESS DEM C1, C2, L, R	Advisory		Demand pump output pressure is low when commanded on.
HYD PRESS PRI C1, C2	Advisory		Primary pump output pressure is low.
HYD PRESS PRI L, R	Advisory		Primary pump output pressure is low.
HYD PRESS SYS C	Caution	Beeper	Center hydraulic system pressure is low.
HYD PRESS SYS L	Caution	Beeper	Left hydraulic system pressure is low.
HYD PRESS SYS L+C	Caution	Beeper	Left and center hydraulic system pressures are low.
HYD PRESS SYS L+C+R	Caution	Beeper	All hydraulic system pressures are low.
HYD PRESS SYS L+R	Caution	Beeper	Left and right hydraulic system pressures are low.
HYD PRESS SYS R	Caution	Beeper	Right hydraulic system pressure is low.
HYD PRESS SYS R+C	Caution	Beeper	Right and center hydraulic system pressures are low.
HYD QTY LOW C, L, R	Advisory		Hydraulic quantity is low.
RAT UNLOCKED	Advisory		RAT is not stowed and locked.

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TOC-2	11/01/00				
1	11/01/00				
2	11/01/00				
* 3	11/01/02				
4	11/01/00				
5	05/01/01				
6	11/01/00				
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14	11/01/00				
* LEP-1	11/01/02				
* LEP-2	11/01/02				

* Asterisk indicates page(s) revised or added by the current revision.

LANDING GEAR
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LANDING GEAR

Sec. 6.14 TOC-2

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Continental

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Flight Manual

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LANDING GEAR SYSTEM DESCRIPTION**INTRODUCTION**

The airplane has two main landing gear and a single nose gear. The nose gear is a conventional steerable two-wheel unit. Each main gear has six wheels in tandem pairs. To improve turning radius, the aft axle of each main gear is steerable.

Hydraulic power for retraction, extension, and steering is supplied by the center hydraulic system. An alternate extension system is also provided.

The normal brake hydraulic system is powered by the right hydraulic system. The alternate brake hydraulic system is powered by the center hydraulic system. Antiskid protection is provided with both systems, but the autobrake system is available only through the normal system. A brake temperature monitor system and tire pressure indication system displays each brake temperature and tire pressure on the GEAR synoptic display.

AIR/GROUND SENSING SYSTEM

In-flight and ground operation of various airplane systems are controlled by the air/ground sensing system.

The system receives air/ground logic signals from sensors located on each main landing gear beam. These signals are used to configure the airplane systems to the appropriate air or ground status.

LANDING GEAR OPERATION

The landing gear are normally controlled by the landing gear lever. On the ground, the lever is held in the DN position by an automatic lever lock. The lever lock can be manually overridden by pushing and holding the landing gear lever LOCK OVERRIDE switch. In flight, the lever lock is automatically released through air/ground sensing.

Landing Gear Retraction

When the landing gear lever is moved to UP, the landing gear begins to retract. The landing gear doors open and the main gear wheels tilt to the retract position. The EICAS landing gear position indication display changes from a green **DOWN** indication to a white crosshatch in-transit indication as the landing gear retract into the wheel wells. After retraction, the landing gear are held up by uplocks. The EICAS landing gear position indication changes to UP for 10 seconds and then blanks. With the landing gear retracted and all doors closed, the landing gear hydraulic system is automatically depressurized.

If any gear is not up and locked up after the normal transit time, the EICAS caution message **GEAR DISAGREE** is displayed. The EICAS gear position indication changes to the expanded non-normal format, with the affected gear displayed as in-transit or down, if the gear never unlocked from the down position. The EICAS advisory message **GEAR DOOR** is displayed if any hydraulically actuated door is not closed after normal transit time.

Landing Gear Extension

When the landing gear lever is moved to DN, the landing gear doors open, the gear are unlocked, and the in-transit indication is displayed on the EICAS landing gear position indication.

The gear free-fall without hydraulic power to the down and locked position. The downlocks are powered to the locked position, all hydraulically actuated gear doors close, and the main gear trucks hydraulically tilt to the flight position. When all gear are down and locked, the EICAS gear position indication displays **DOWN**.

The EICAS caution message **GEAR DISAGREE** is displayed if any gear is not locked down (side and drag brace on the same main gear not locked, or nose gear drag brace not locked) after the normal transit time. The EICAS gear position indication changes to the expanded non-normal format, with the affected gear displayed as in transit (or UP if the gear never unlocked from the up position).

If only one brace on a main gear is locked (either drag or side brace not locked) after the normal transit time, the EICAS caution message **MAIN GEAR BRACE L** or **R** is displayed for the affected gear. The EICAS gear position indication changes to the expanded non-normal format, with the affected gear displayed as in transit. The EICAS advisory message **GEAR DOOR** displays if any hydraulically actuated door is not closed after the normal transit time.

Landing Gear Alternate Extension

The alternate landing gear extension system uses a dedicated DC hydraulic pump and trapped center hydraulic system fluid to extend the landing gear. The hot battery bus supplies power to the pump and an oversize tube from the center hydraulic system reservoir supplies fluid. The tube contains enough fluid to do an alternate extension with an empty center hydraulic system reservoir.

Selecting DOWN on the ALTERNATE GEAR switch releases all door and gear uplocks. The landing gear free-fall to the down and locked position without sequencing, and do not tilt. The landing gear lever position has no effect on landing gear alternate extension.

The EICAS landing gear position indication displays the expanded gear position indication when the alternate extension system is used. During alternate extension, the EICAS message **GEAR DOOR** is displayed because all the hydraulically powered gear doors remain open.

Following an alternate extension, the landing gear can be retracted by the normal system, if it is operating. Select DN then UP to retract the landing gear using the normal system.

NOSE WHEEL AND MAIN GEAR AFT AXLE STEERING

The airplane is equipped with nose wheel steering and main gear aft axle steering.

Nose wheel steering is powered by the center/reserve hydraulic system. Main gear aft axle steering is powered by the center hydraulic system.

Primary steering control is provided by a nose wheel steering tiller for each pilot. Limited steering control is available through the rudder pedals. The tillers can turn the nose wheels up to 70 degrees in either direction. A pointer on the tiller assembly shows tiller position relative to the neutral setting. The rudder pedals can be used to turn the nose wheels up to 7 degrees in either direction. Tiller inputs override rudder pedal inputs.

Main gear aft axle steering automatically operates when the nose wheel steering angle exceeds 13 degrees. This reduces tire scrubbing and lets the airplane turn in a minimum radius.

The EICAS warning message **CONFIG GEAR STEERING**, accompanied by the takeoff configuration aural alert, is displayed if the main gear aft axles are not centered and locked when takeoff thrust is applied. The EICAS advisory message **MAIN GEAR STEERING** is displayed if the main gear steering actuators are not locked in the centered position when commanded to the center position.

BRAKE SYSTEM

Each main gear wheel has a multiple disc carbon brake. The nose wheels have no brakes. The brake system includes:

- Normal brake hydraulic system
- Alternate/reserve brake hydraulic system
- Brake accumulator
- Antiskid protection
- Autobrake system
- Parking brake.

Normal Brake Hydraulic System

The normal brake hydraulic system is powered by the right hydraulic system. The brake pedals provide independent control of the left and right brakes.

Alternate/Reserve Brake Hydraulic System

Alternate/reserve brake hydraulic system selection is automatic. If the right hydraulic system pressure is low, the center/reserve hydraulic system automatically supplies pressure to the alternate/reserve brake hydraulic system. Pushing a brake pedal then sends hydraulic pressure through the alternate antiskid valves to the brakes. If center hydraulic system fluid quantity is low, the C1 primary pump is isolated from the center hydraulic system to provide a reserve braking pressure source.

Loss of the right and center/reserve hydraulic systems causes the **BRAKE SOURCE** light to illuminate and the EICAS advisory message **BRAKE SOURCE** to display.

Brake Accumulator

The brake accumulator is located in the normal brake hydraulic system.

If right and center/reserve brake hydraulic power is lost, the brake accumulator can provide several braking applications or parking brake application.

Antiskid Protection

Antiskid protection is provided in the normal and alternate brake hydraulic systems.

Antiskid protection is also provided when the brake system is being supplied pressure only from the brake accumulator.

The normal brake hydraulic system provides each main gear wheel with individual antiskid protection. When a wheel speed sensor detects a skid, the associated antiskid valve reduces brake pressure until skidding stops.

The alternate / reserve brake hydraulic system provides antiskid protection to tandem wheel pairs for the forward and middle axle wheels. The aft axle wheels remain individually controlled.

Touchdown and hydroplaning protection is provided using airplane inertial ground speed. Locked wheel protection is provided using a comparison with other wheel speeds.

The EICAS advisory message **ANTISKID** is displayed if an antiskid fault affecting the brake hydraulic system in use is detected, or if the parking brake valve is not fully open with the parking brake released, or if the system is completely inoperative.

Autobrake System

The autobrake system provides automatic braking at preselected deceleration rates for landing and full pressure for rejected takeoff. The system operates only when the normal brake system is functioning. Antiskid system protection is provided during autobrake operation.

EICAS memo messages display the selected autobrake settings:

- **AUTOBRAKE 1** through **4**
- **AUTOBRAKE MAX**
- **AUTOBRAKE RTO**

The EICAS advisory message **AUTOBRAKE** is displayed if the autobrake system is disarmed or inoperative, or autobrake solenoid valve pressure is high when not commanded on.

Rejected Takeoff

Selecting RTO (rejected takeoff) prior to takeoff arms the autobrake system. The RTO mode can be selected only on the ground. The RTO autobrake setting commands maximum braking pressure if:

- The airplane is on the ground
- Groundspeed is above 85 knots, and
- Both thrust levers are retarded to idle.

Maximum braking is obtained in this mode. If an RTO is initiated below 85 knots, the RTO autobrake function does not operate.

Taxi Brake Release

During each taxi brake application, the antiskid system releases the brakes of one axle pair of each main landing gear (if wheel speeds are less than 45 knots). The system sequences through the axle pairs at each brake application, thereby reducing the number of brake applications by each brake. This extends service life and reduces brake sensitivity during taxi.

All active brakes are applied for a heavy brake application, landing rollout, RTO, or when setting the parking brake.

The taxi brake release system operates only with the normal brake hydraulic system.

Landing

Five levels of deceleration can be selected for landing. However, on dry runways, the maximum autobrake deceleration rate in the landing mode is less than that produced by full pedal braking.

After landing, autobrake application begins when:

- Both thrust levers are retarded to idle, and
- The wheels have spun up.

Autobrake application occurs slightly after main gear touchdown. If MAX AUTO is selected, deceleration is limited to the AUTOBRAKE 4 level until pitch angle is less than one degree, then deceleration is increased to the MAX AUTO level. The deceleration level can be changed (without disarming the system) by rotating the selector.

To maintain the selected airplane deceleration rate, autobrake pressure is reduced as other controls, such as thrust reversers and spoilers, contribute to total deceleration. The system provides braking to a complete stop or until it is disarmed.

Autobrake - Disarm

The system disarms immediately and the EICAS advisory message **AUTOBRAKE** is displayed if any of the following occur:

- Pedal braking applied
- Either thrust lever advanced after landing
- Speedbrake lever is moved to the DOWN detent after the speedbrakes have deployed on the ground
- DISARM OR OFF position selected on the AUTOBRAKE selector
- Autobrake fault
- Normal antiskid system fault
- Loss of inertial data from the ADIRU
- Loss of normal brake hydraulic pressure.

When the autobrake system disarms after landing, the AUTOBRAKE selector automatically moves to the DISARM position, and removes power from the autobrake system.

When the autobrake system disarms during takeoff, the autobrake selector remains in the RTO position, but automatically moves to OFF after takeoff.

Parking Brake

The parking brake can be set with the normal or alternate brake hydraulic system pressurized. If the normal and alternate brake systems are not pressurized, parking brake pressure is maintained by the brake accumulator. The brake accumulator is pressurized by the right hydraulic system. Accumulator pressure is shown on the BRAKE ACCUMULATOR PRESSURE indicator.

The parking brake is set by depressing both brake pedals fully, while simultaneously pulling the parking brake lever up. This mechanically latches the pedals in the depressed position and commands the parking brake valve to close.

The parking brake is released by depressing the pedals until the parking brake lever releases.

When the parking brake is set, the EICAS memo message **PARKING BRAKE SET** is displayed. If the parking brake is set and either engine is set to takeoff thrust, the takeoff configuration aural alert sounds and the EICAS warning message **CONFIG PARKING BRAKE** is displayed.

Brake Temperature Indication

Wheel brake temperatures are displayed on the GEAR synoptic display. Numerical values related to wheel brake temperature are displayed adjacent to each wheel/brake symbol. These values range from 0.0 to 9.9 in increments of 0.1. The values tend to increase after the brakes are used.

Normal range values of 0 to 4.9 are white. For values of 3.0 to 4.9, the brake symbol for the hottest brake becomes solid white. Values of 5.0 and above are amber. For values of 5.0 and above, the EICAS advisory message **BRAKE TEMP** is displayed.

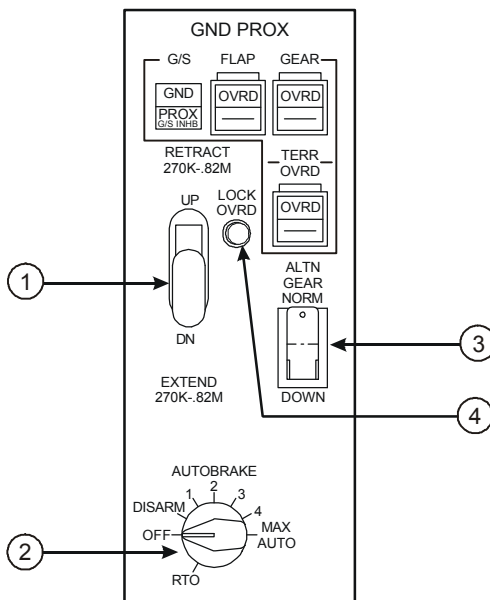
Tire Pressure Indication

Individual tire pressures, from 0 to 400 PSI, are displayed inside the individual wheel symbols on the GEAR synoptic display.

The EICAS advisory message **TIRE PRESS** is displayed if any tire pressure is above or below the normal range, or there is an excessive pressure difference between two tires on the same axle.

CONTROLS AND INDICATORS

LANDING GEAR PANEL



CENTER FORWARD PANEL

7771908

① Landing Gear Lever

UP - The landing gear retracts.

DN - The landing gear extends.

② AUTOBRAKE Selector

OFF - Deactivates and resets the autobrake system.

DISARM -

- Disengages the autobrake system
- Releases brake pressure.

1, 2, 3, 4, MAX AUTO - Selects the desired deceleration rate.

RTO - Automatically applies maximum brake pressure when the thrust levers are retarded to idle above 85 knots.

③ Alternate Gear (ALTN GEAR) Switch

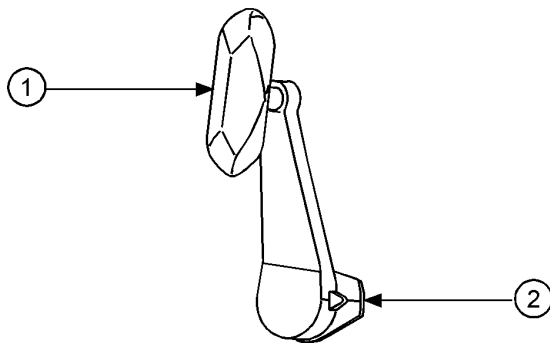
NORM - the landing gear lever operates normally.

DOWN - the landing gear extends by the alternate extension system.

Note: Alternate extension may be selected with the landing gear lever in any position.

④ Landing Gear Lever Lock Override (LOCK OVRD) Switch

Push - releases the landing gear lever lock.

NOSE WHEEL STEERING TILLER

7771902

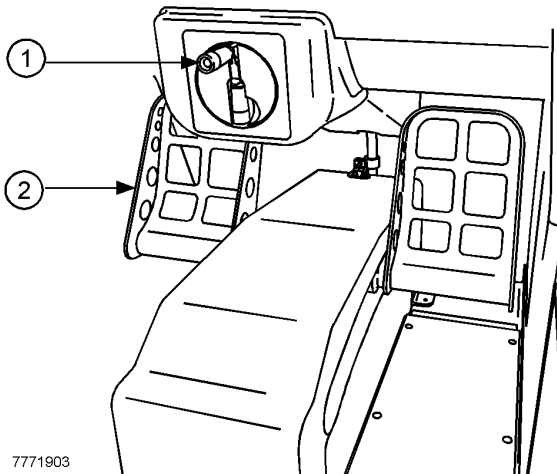
LEFT AND RIGHT SIDEWALLS**① Nose Wheel Steering Tiller**

Rotate -

- Turns the nose wheels up to 70 degrees in either direction
- Overrides rudder pedal steering
- Main gear aft axle steering is slaved to nose wheel steering.

② Tiller Position Indicator

Shows tiller displacement from the straight-ahead, neutral position.

BRAKE SYSTEM

7771903

RUDDER/BRAKE PEDALS**① Rudder Pedal Adjust Crank**

Adjusts the rudder pedals forward or aft.

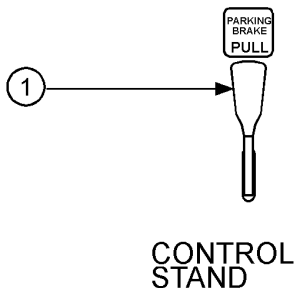
② Rudder/Brake Pedals

Pushing the full pedal:

- Turns the nose wheel up to 7 degrees in either direction
- Does not activate main gear steering.

Push the top of the pedals - actuates the wheel brakes.

Refer to Section 6.9, Flight Controls for the description of rudder operation.

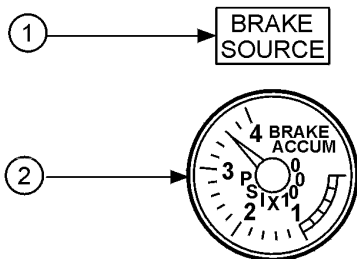
PARKING BRAKE LEVER

7771904

① Parking Brake Lever

Pull - Sets the parking brake when both brake pedals are simultaneously depressed.

Release - Simultaneously depress both brake pedals.

BRAKE ACCUMULATOR PRESSURE INDICATOR

7771905

LEFT FORWARD PANEL

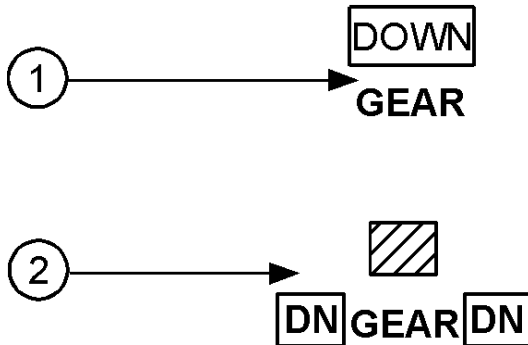
① BRAKE SOURCE Light

Illuminated (amber) - Both active brake hydraulic sources (right and center/reserve hydraulic systems) have low pressure.

② BRAKE ACCUMULATOR PRESSURE Indicator

Indicates brake accumulator pressure.

LANDING GEAR SYSTEM INDICATIONS



EICAS DISPLAY

7771906

LANDING GEAR POSITION INDICATIONS

① Gear Position Indication (Normal Display)

DOWN (green) - All landing gear are down and locked.

Crosshatched (white) - One or more landing gear are in transit.

UP (white) - All landing gear are up and locked (blanks after 10 seconds).

Empty box (white) - All landing gear position indicators are inoperative.

② Expanded Gear Position Indication (Non-Normal Display)

DN (green) - The associated landing gear is down and locked.

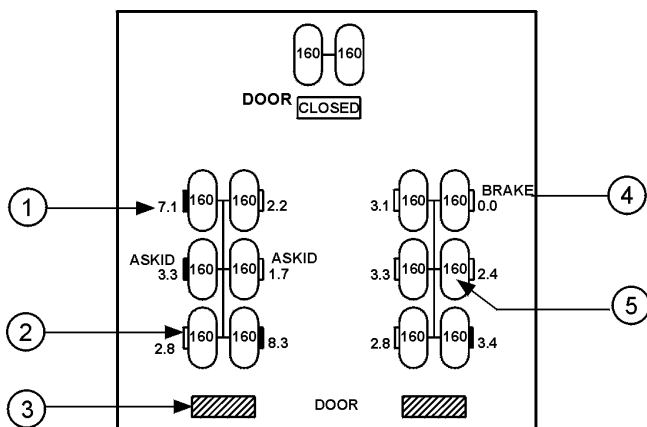
Crosshatched (white) - The associated landing gear is in transit.

UP (white) - The associated landing gear is up and locked.

Empty box (es) (white) - The associated landing gear position indicators are inoperative.

GEAR SYNOPTIC DISPLAY

The landing gear synoptic is displayed by pushing the GEAR synoptic display switch on the display select panel. Display select panel operation is described in Section 6.10, Flight Instruments, Displays.



MULTIFUNCTION DISPLAY

7771907

① Brake Temperature

Indicates a relative value of wheel brake temperature:

- Values range from 0.0 to 9.9
- White - normal range
- Amber - high range.

② Brake Symbol

Blank box indicates any brake less than 3.0.

Solid white box indicates hottest brake on each main gear within range of 3.0 to 4.9.

Solid amber box indicates brake overheat condition on each wheel within range of 5.0 to 9.9.

③ Gear Door Status

Crosshatched - The door is not closed.

CLOSED (white) - The door is closed.

Empty box(es) (white) - The associated landing gear door position indicators are inoperative.

④ Fault Indication (amber)

BRAKE - Indicates brake deactivation on the associated wheel.

ASKID - Indicates antiskid fault on the associated wheel.

⑤ Tire Pressure Indication

Displays individual tire pressures:

- White - normal range
- Amber - abnormal high or low range.

LANDING GEAR EICAS MESSAGES

The following EICAS messages can be displayed.

Note: Configuration warning messages are covered in Chapter 6.15, Warning Systems.

Brakes

Message	Level	Aural	Condition
ANTISKID	Advisory		A fault is detected in the anti-skid system.
AUTOBRAKE	Advisory		Autobrake is disarmed or inoperative.
AUTOBRAKE 1, 2, 3, 4, MAX, RTO	Memo		Indicates selected autobrake level.
BRAKE SOURCE	Advisory		Normal, alternate, and reserve brakes are not available.
BRAKE TEMP	Advisory		Temperature of one or more brakes is excessive.
CONFIG PARKING BRAKE	Warning	Siren	Parking brake is set when either engine's thrust is in the takeoff range on the ground.
PARKING BRAKE SET	Memo		The parking brake lever is up and the parking brake valve is closed.
RESERVE BRAKES/STRG	Advisory		Reserve brakes, normal nose gear extension, and nose wheel steering may not be available.

Landing Gear

Message	Level	Aural	Condition
CONFIG GEAR	Warning	Siren	Any landing gear is not down and locked when either thrust lever is closed below 800 feet radio altitude or when flaps are in a landing position.
CONFIG GEAR STEERING	Warning	Siren	Main gear steering is unlocked when either engine's thrust is in the takeoff range on the ground.
GEAR DISAGREE	Caution	Beeper	Gear position disagrees with landing gear lever position.
GEAR DOOR	Advisory		One or more gear doors are not closed.
MAIN GEAR BRACE L, R	Caution	Beeper	A brace on the affected main gear is unlocked.
MAIN GEAR STEERING	Advisory		Main gear steering is unlocked when centered.
VMO GEAR DOWN	Memo		<p>The Alternate Gear Down Dispatch switch is in the VMO position. (Limits V_{MO}/M_{MO} to 270/.73 for dispatching the aircraft with gear locked down.)</p> <p>If displayed for normal operations, call maintenance and request that the AGDD switch be positioned to NORMAL.</p> <p><u>Note:</u> Not immediately accessible to the flight crew. The switch is located in the E/E bay, adjacent to the E/E bay light switches on a bracket just above the Main Equipment Center Lower Access Door.</p>

Tires

Message	Level	Aural	Condition
TIRE PRESS	Advisory		One or more tire pressures are not normal.

LIST OF EFFECTIVE PAGES

PAGE	DATE	PAGE	DATE	PAGE	DATE
TOC-1	11/01/01				
TOC-2	11/01/01				
1	11/01/00				
2	11/01/00				
3	11/01/00				
* 4	05/01/02				
* 5	05/01/02				
6	11/01/00				
7	11/01/00				
8	11/01/00				
9	11/01/00				
10	11/01/00				
11	11/01/00				
12	11/01/00				
13	11/01/00				
14	11/01/00				
15	11/01/00				
16	11/01/00				
17	11/01/01				
18	11/01/01				
* LEP-1	05/01/02				
* LEP-2	05/01/02				

* Asterisk indicates page(s) revised or added by the current revision.

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WARNING SYSTEMS DESCRIPTION

INTRODUCTION

The warning systems consist of four separate systems:

- Engine Indication And Crew Alerting System (EICAS)
- Warning System
- Ground Proximity Warning System (GPWS)
- Traffic Alert And Collision Avoidance System (TCAS).

These systems provide all aircraft crew alerting.

Alert is defined as a visual, tactile and/or aural alert requiring crew awareness and possible crew action.

ENGINE INDICATION AND CREW ALERTING SYSTEM (EICAS)

EICAS consolidates engine and subsystem indications and provides a centrally located crew alerting message display. EICAS also displays some system status and maintenance information. EICAS provides:

- | | |
|------------------------|----------------------------|
| • System alerts | • Status messages |
| • Communication alerts | • Maintenance information. |
| • Memo messages | |

System Alert Messages

System alert messages are normally associated with system failures or faults that may require performance of a specific non-normal procedure, or affect the way the flight crew operates the aircraft. There are four categories of crew alerts:

- Time critical warning
- Caution
- Warning
- Advisory.

Non-normal aircraft system conditions, not effecting the normal operation of the aircraft, are not alert conditions. These are annunciated using status or maintenance messages.

System alert messages not directly caused by system failures or faults include such situations as:

- Altitude alert
- Ground proximity warnings and cautions
- Configuration warnings
- Overspeed warning
- FMC messages (refer to Section 6.10, Flight Management, Navigation)
- Stall warning
- TCAS warnings.
- Windshear warning

Non-normal operational conditions do not include:

- ACARS messages
- Printer messages
- Communication indications
- SELCAL.
- Interphone calls

System Alert Level Definitions

Time Critical Warnings

Time critical warnings alert the crew of a non-normal operational conditions requiring immediate crew awareness and corrective action to maintain safe flight. Time critical warnings are usually associated with primary flight path control. Master warning lights, voice alerts, and PFD indications or stick shakers announce time critical warning conditions.

Warnings

Warnings alert the crew to a non-normal operational or system condition requiring immediate crew awareness and corrective action.

Cautions

Cautions alert the crew to a non-normal operational or system condition requiring immediate crew awareness. Corrective action may be required.

Advisories

Advisories alert the crew to a non-normal operational or system condition requiring routine crew awareness. Corrective action may be required.

Communication Alerts

Communication alerts are triggered by the communication management system. These alerts direct the crew to the appropriate message display:

- Multifunction display (MFD)
- Audio control panel
- Cabin interphone
- Printer
- FMC.

There are three levels of communication alert:

- High - Reserved for future use.
- Medium - Identify an incoming communication requiring immediate awareness and a prompt response. It is accompanied by an aural chime.
- Low - Identifies an incoming communication requiring timely awareness and response.

A detailed description of the communication management system is described in Section 6.5, Communications.

Memo Messages

Memo messages support normal aircraft operations and are not considered crew alerts.

Memo messages indicate the current state of certain manually and automatically configured aircraft systems. Memo messages are displayed (white font) on the EICAS display.

Status Messages

Status messages identify system faults affecting aircraft dispatch and are not considered crew alerts. Status messages are displayed on the MFD STATUS page and must be cleared by maintenance before departure.

Status messages that appear during flight, should be written up in the aircraft logbook, with no further action by the flight crew.

Alert Message Displays

System alerts, communication alerts, and memo messages are displayed in both prioritized and chronological order. The priority in descending order is:

- Warning (red)
- Caution (amber)
- Advisory (amber, indented)
- Medium level communication (white, preceded by a dot)
- Low level communication (white, indented, preceded by a dot)
- Memo (white)

Warnings, cautions, and advisories are displayed from the top down in the EICAS display message area. Communication alerts and memo messages are displayed at the bottom of the message area.

The most recent message is displayed at the top of its respective level. An overflow of system and/or communication alert messages displaces memo messages. An overflow of system alert messages displaces communication alerts. The bottom line of the EICAS message field (line 11) is reserved for a communication alert (medium or low) if one is active. The communication alert line can not be displaced by a system alert even if more than 10 lines are active.

If the number of messages exceeds eleven, the area below the alert field displays a page cue, indicating more than one page of messages is available for display. Paging is accomplished by pushing the CANCEL/RECALL switch on the display select panel.

All caution and advisory alerts can be cleared. Warning alerts, communication alerts, and memo messages cannot be cleared. When the last page is displayed, pushing the CANCEL/RECALL switch clears all displayed caution and advisory alerts. Cleared caution and advisory alerts whose conditions still exist can be recalled by pushing the CANCEL/RECALL switch again. This also recalls the first page for review.

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MASTER WARNING/CAUTION RESET SWITCHES AND LIGHTS

Two master warning/caution reset switches each contain a master **WARNING** light and master **CAUTION** light.

The red master **WARNING** lights illuminate when any warning alert or time critical warning occurs (except a stall warning). The lights remain illuminated as long as the warning alert exists or until either master warning/caution reset switch is pushed. Pushing either switch:

- Extinguishes both master **WARNING** lights
- Resets the lights for future **WARNING** alerts.

Pushing either master warning/caution reset switch also silences the warning siren and fire bell except for the following warnings:

- Takeoff configuration
- Landing configuration (for example, when the flap lever is in a landing flap setting and landing gear are not down).
- Overspeed
- Autopilot disconnect

The amber master **CAUTION** lights illuminate when any caution alert occurs. The lights remain on as long as the caution alert exists or until either master warning/caution reset switch is pushed. Pushing either switch:

- Extinguishes both master **CAUTION** lights
- Resets the lights for future caution alerts.

Flight Deck Panel Annunciator Lights

Flight deck panel annunciator lights are used in conjunction with EICAS messages to:

- Help locate and identify affected systems and controls
- Reduce the potential for error.

The annunciator lights provide system feedback in response to flight crew action. The lights also assist in fault detection and system preflight configuration when the engines are shut down, and to supplement EICAS information.

AURAL ALERTS

Aural alerts are provided to ensure crew attention, recognition, and response.

Aural alerts include synthetic voices and tones. Aural voice alerts are the most direct and rapid method of communicating a specific alert condition to the crew. Aural tones are used to alert the crew and to discriminate between the different alert types and levels.

Aural alerts annunciate time critical warning, warning, caution, and medium level communication alerts. There are no aural alerts associated with advisory level alerts or low level communication alerts.

The aural alerts are:

- **Beeper** - Used for all system alert caution level messages. The beeper consists of a tone that sounds four times in a second. The beeper automatically silences after one series of four beeps.
- **Bell** - Used for fire warnings. The bell sounds repeatedly until crew action is initiated.
- **Chime** - A high-low tone chime used for medium level communication alerts. The chime sounds once for each communication alert.
- **Siren** - Used to annunciate warning alerts. The siren consists of alternating high and low tones.
- **Voice** - Synthetic voices annunciate time critical warning alert conditions, such as GPWS, engine fail, and TCAS alerts. Synthetic voices also annunciate certain normal but time critical operational information, such as approach phase altitude callouts and the V₁ callout.
- **Wailer** - Used to annunciate autopilot disconnect.
- All continuous aural alerts are silenced automatically when the respective alert condition no longer exists.

Alert Inhibits

Alerts are inhibited during part of the takeoff in order not to distract the crew. Alerts are also inhibited when they are operationally unnecessary or inappropriate.

Alert messages, except for warnings and messages directly relevant to flight operations, are inhibited during engine start to eliminate nuisance messages.

Alert messages are inhibited individually at other times, such as during the preflight and postflight phases or engine shutdown, when they are operationally unnecessary.

Message Consolidation

On the ground with both engines shut down, certain caution and advisory alert messages are inhibited by collecting them into more general alert messages. These include individual fuel, hydraulic, door, and electrical messages. For example, two or more individual entry, cargo, and access door EICAS messages are replaced by the EICAS advisory message **DOORS**.

Engine Start Message Inhibits

During ground engine start, new caution and advisory alerts are inhibited from engine start switch engagement until:

- The engine reaches idle RPM
- The start is aborted, or
- 5 minutes elapse from engine start switch engagement whichever occurs first.

The following messages are not inhibited:

- | | |
|-----------------------------|------------------------------|
| • APU LIMIT | • FMC MESSAGE |
| • APU SHUTDOWN | • FUEL VALVE APU |
| • ENG FUEL VALVE | • LANDING ALTITUDE |
| • ENG SHUTDOWN | • OUTFLOW VALVE |
| • ENG AUTOSTART | • OVERHEAT ENG |
| • ENG STARTER CUTOUT | • SGL SOURCE DISPLAYS |
| • ENG START VALVE | |

Takeoff Inhibits

The master **WARNING** lights and fire bell are inhibited for fire during part of the takeoff. The inhibit begins at V_1 and ends at 400 feet radio altitude, or 25 seconds after V_1 , whichever occurs first. If a fire occurs during the inhibit, an EICAS warning message appears, but the master **WARNING** lights do not activate. If the warning condition still exists when the inhibit is removed, both master **WARNING** lights and the appropriate warning aural activate immediately.

If the master **WARNING** lights and fire bell or siren are activated prior to the inhibit they continue to illuminate and sound after reaching V_1 .

Takeoff configuration warnings are terminated when airspeed exceeds V_1 .

The landing configuration master warning lights and siren are inhibited from rotation to 800 feet radio altitude, or for 140 seconds after nose gear strut extension, whichever occurs first.

The master **CAUTION** lights and aural beeper are inhibited for all cautions during part of the takeoff. The inhibit begins at 80 knots and ends at 400 feet radio altitude, or 20 seconds after rotation, whichever occurs first. If a rejected takeoff is initiated above 80 knots, the inhibit remains until the airspeed decreases below 75 knots. If the master **CAUTION** lights and the aural alerts are activated prior to the inhibit, they continue to illuminate and sound.

The inhibit cannot reset the lights or aural alert. If a caution occurs during the inhibit and exists when inhibit ends, both master **CAUTION** lights and aural activate. Caution alert messages are not inhibited during takeoff.

Advisory message inhibits begin at 80 knots and end at 400 feet radio altitude, or 20 seconds after rotation, whichever occurs first. The inhibit is also terminated if takeoff thrust is not selected on both engines.

Communication alert messages (except **CABIN ALERT**) and the aural chimes are inhibited on takeoff from the time either engine is advanced to takeoff thrust through 400 feet radio altitude, or until 20 seconds after rotation. The inhibit is cleared if the aircraft is on the ground with both engines below takeoff thrust. If a communication alert occurs during the inhibit and exists when the inhibit ends, the message is displayed and the aural chime sounds.

The EICAS display **STATUS** message cue is inhibited from engine start until 30 minutes after liftoff.

Landing Inhibits

When **LAND 2** or **LAND 3** are displayed, the master **CAUTION** lights and beeper associated with most EICAS caution messages are inhibited from 200 feet AGL until:

- Less than 75 knots groundspeed
- 40 seconds has elapsed, or
- Radio altitude is greater than 800 feet.

EICAS caution messages are not inhibited.

The master **CAUTION** lights and beeper for EICAS caution messages that may require a go-around are not inhibited. They are:

- | | |
|----------------------|------------------------------|
| • AUTOPILOT | • SPEEDBRAKE EXTENDED |
| • NO AUTOLAND | • AUTOTHROTTLE DISC |

The **STATUS** message cue, communication messages (except **CABIN ALERT**), and communication aural chimes are inhibited on descent from 800 feet radio altitude to 75 knots groundspeed.

Engine Shutdown Inhibits

Engine-driven pumps, generators, and other components whose alert messages would result from an engine shutdown, are inhibited by the **ENG SHUTDOWN** message. When an engine is shutdown (FUEL CONTROL switch in cutoff or fire handle pulled), the EICAS alert message **ENG SHUTDOWN L** or **ENG SHUTDOWN R** is displayed and the following L or R alerts are inhibited:

- | | |
|-----------------------|--------------------------|
| • BLEED OFF | • ELEC BACKUP GEN |
| • ELEC DRIVE | • ENG OIL PRESS |
| • ELEC GEN OFF | • HYD PRESS PRI |

When the aircraft is on the ground and both FUEL CONTROL switches are in the CUTOFF position, the master **CAUTION** lights and the caution alert beeper are inhibited. This prevents alerts associated with routine gate operations from triggering nuisance lights and aural alerts. On the ground with both engines shut down; the EICAS alert message **ENG SHUTDOWN** is displayed without an L or R following it.

When the shutdown inhibit is removed, the master **CAUTION** lights and alert beeper do not activate for alerts that existed prior to its removal. For example, if the right hydraulic system is depressurized with both engines shutdown, and the left engine is then started, the master **CAUTION** lights and beeper do not activate. The master **CAUTION** lights and beeper activate only when the alert first occurs, provided no other inhibit is in effect.

Alert Message Inhibits

Alert message inhibits are those inhibits where one message is inhibited by the presence of another alert message. For example, individual fuel or hydraulic pump pressure messages are inhibited by higher priority system pressure messages.

Certain alert messages are time delayed, even though discrete system lights may illuminate. Time delay inhibits prevent normal in-transit indications from appearing as EICAS system alert messages. For example, valves are generally only sensed open and/or closed, not in-transit. When a valve is in-transit, the alert message indicating the valve has failed to open or close is inhibited to allow the valve time to move to the commanded position. If the valve is not in the commanded position at the end of the inhibit period, an EICAS system alert message is displayed.

Altitude Alerting Inhibit

Altitude alerting is inhibited in flight with:

- Glide slope capture, or
- Landing flaps (25 or 30) selected and all landing gear down.

Master Caution Lights and Beeper Inhibit

The master **CAUTION** lights and the associated aural beeper are inhibited for the following caution level messages:

- **ENG SHUTDOWN L and R**
- **ENG FAIL L and R** (following a time critical warning only).

EICAS Event Record

The flight crew can manually capture and record any suspect condition into EICAS memory using the EICAS EVENT RECORD switch.

Systems, which provide recorded information when the switch is activated, include:

- Anti-ice, ice detection
- Air systems
- APU
- Electrical
- Electronic engine control
- Fire protection
- Flight controls / flaps and slats
- Fuel quantity and fuel management
- Hydraulic
- Landing gear and brakes
- Performance.

Up to five parameter sets may be manually recorded. The event record function also has an automatic feature. When an EICAS event occurs, conditions are automatically written to EICAS memory.

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WARNING SYSTEM

The warning system consists of two flight deck warning speakers, two master **WARNING** lights and two stick shaker motors.

The warning system controls and activates visual and/or aural alerts for these warnings:

- Fire
- Engine fail
- Cabin altitude
- Autopilot disconnect
- Crew alertness
- Unscheduled stabilizer movement
- Ground proximity
- Windshear
- Overspeed
- Traffic Alert and Collision Avoidance System (TCAS)
- Takeoff and Landing Configuration
- Stall Warning.

Takeoff Configuration Warnings

Takeoff configuration warnings are armed when the aircraft is on the ground and thrust is in the takeoff range on either engine. Takeoff configuration warnings are also armed when the aircraft is on the ground and the Takeoff Check switch is pushed. Takeoff configuration warnings consist of:

- Master **WARNING** lights illuminate
- Aural warning siren sounds
- Applicable EICAS warning alert **CONFIG** message(s) are displayed.

Takeoff configuration warning messages include:

- **CONFIG DOORS**
- **CONFIG FLAPS**
- **CONFIG GEAR STEERING**
- **CONFIG PARKING BRAKE**
- **CONFIG RUDDER**
- **CONFIG SPOILERS**
- **CONFIG STABILIZER**

All takeoff configuration warning indications are canceled when the configuration error is corrected. Additionally, takeoff configuration warnings are disarmed at V_1 . Any existing takeoff configuration warning indications are inhibited above V_1 .

When a takeoff configuration warning occurs, pushing either master warning/caution reset switch resets the master **WARNING** lights but does not silence the siren or clear the EICAS alert message. Before reaching V_1 , the siren can be silenced and the EICAS alert message cleared only by retarding both thrust levers or correcting the condition. If thrust is reduced, the EICAS takeoff configuration message remains displayed for 10 seconds so the pilots can positively identify the configuration problem.

Landing Configuration Warning

The landing configuration warning system alerts the crew that the landing gear is not extended for landing. The landing configuration warning activates if:

- The aircraft is in flight, and
- Any landing gear is not down and locked, and
- Either of the following conditions exists:
 - Flap lever in a landing position (25 or 30), or
 - Any thrust lever is at idle with radio altitude 800 feet or less.

The landing configuration warning consists of:

- Master **WARNING** lights illuminate
- Aural warning siren activates
- The **CONFIG GEAR** EICAS warning alert message is displayed.

With the flap lever in a landing position, the siren and alert message cannot be deactivated with the master warning/caution reset switches. The siren and message continue until the condition is corrected or the ground proximity gear override switch is pushed.

If the warning is due to an idle thrust setting at low altitude, pushing either master warning/caution reset switch silences the siren and extinguishes the master **WARNING** lights. The EICAS message remains displayed until the configuration error is corrected.

Stall Warning

Warning of an impending stall is provided by left and right stick shakers, which independently vibrate the left and right control columns.

Airspeed Low

The EICAS caution message **AIRSPEED LOW** is displayed and the current airspeed box on the PFDs turn amber when airspeed is below minimum maneuvering speed.

Overspeed Warning

An overspeed warning occurs if V_{MO}/M_{MO} limits are exceeded. The overspeed warning consists of:

- Master **WARNING** lights illuminate
- Aural warning siren sounds
- The EICAS warning alert message **OVERSPEED** is displayed.

The warning siren and EICAS message remain activated until airspeed is reduced below V_{MO}/M_{MO} .

Altitude Alert

Altitude alerting occurs when approaching or departing the MCP-selected altitude.

Approaching a Selected Altitude

At 900 feet prior to reaching the selected altitude, a white box is displayed on the PFD altitude indication around:

- The selected altitude
- The current altitude.

At 200 feet prior to the selected altitude, the white boxes are no longer displayed.

Selected Altitude Deviation

When deviating by 200 feet from the selected altitude:

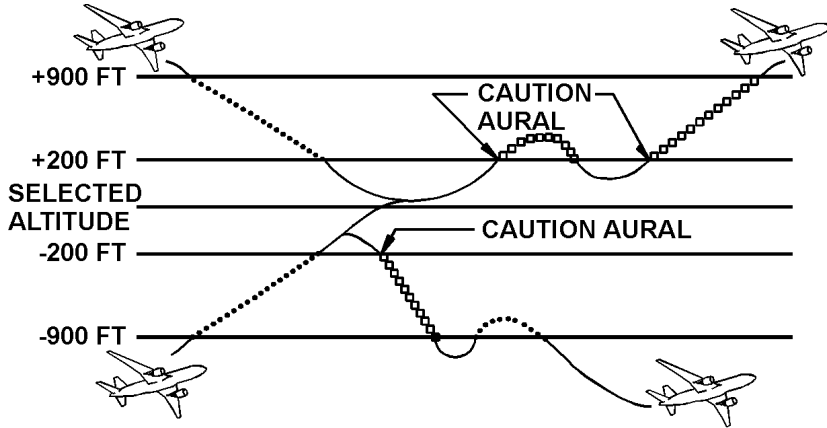
- The master caution lights illuminate
- The EICAS caution message **ALTITUDE ALERT** is displayed
- The caution beeper sounds
- The PFD current altitude box changes to amber.

When deviating more than 900 feet from the selected altitude, or upon returning to within 200 feet of the selected altitude:

- The master caution lights extinguish
- The EICAS caution message is no longer displayed
- The PFD current altitude box changes to white.

Altitude alerting can be reset by changing the selected altitude.

Altitude alerting is inhibited when the glideslope is captured, or with landing flaps selected and the landing gear down.



— No indications

- • • A white box is displayed around each of the PFD selected altitude and current altitude displays.
- □ □ The EICAS caution message ALTITUDE ALERT is displayed and the PFD current altitude box changes to amber.

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ALTITUDE ALERT PROFILE

Ground Proximity Warning System (GPWS)

The GPWS provides alerts for potentially hazardous flight conditions involving imminent impact with the ground.

Ground proximity time critical warnings are accompanied by master **WARNING** light illumination and voice aural alerts. Ground proximity cautions are accompanied by ground proximity light illumination and a voice aural alert.

Note: The GPWS does not provide an alert for flight toward vertically sheer terrain or slow descents into terrain while in the landing configuration.

GPWS Annunciations

Aural Alert	Visual Alert	Description
Two-tone siren followed by "WINDSHEAR"	Red WINDSHEAR message displayed on both PFDs. Master WARNING lights	Time critical warning alert. Excessive windshear condition detected when below 1500 feet. Windshear detection begins at rotation.
"WHOOOP WHOOOP PULL UP"	PULL UP message displayed on both PFDs. Master WARNING lights	Follows SINK RATE alert if descent rate becomes severe. Also follows TERRAIN alert if excessive terrain closure rate continues and landing gear and/or flaps are not in landing configuration.
"DON'T SINK"	GND PROX light	Excessive altitude loss after takeoff or go-around.
"GLIDE SLOPE"	GND PROX light	Deviation below glideslope. Volume and repetition rate increase as deviation increases. Pushing the ground proximity G/S INHIB switch cancels or inhibits the alert below 1000 feet radio altitude.
"SINK RATE"	GND PROX light	Excessive descent rate.
"TERRAIN"	GND PROX light Master WARNING lights	Excessive terrain closure rate.
"TOO LOW FLAPS"	GND PROX light	Unsafe terrain clearance at low airspeed with flaps not in landing configuration. Pushing the ground proximity FLAP override switch to OVRD inhibits the alert.

“TOO LOW GEAR”	GND PROX light	Unsafe terrain clearance at low airspeed with landing gear not down. Pushing the ground proximity GEAR override switch to OVRD inhibits the alert.
“TOO LOW TERRAIN”	GND PROX light	Unsafe terrain clearance at high airspeed with either landing gear not down or flaps not in landing position. Follows DO NOT SINK if another descent is initiated after initial alert, before climbing to the altitude where the initial descent began.

If illuminated, pushing a master warning/caution reset switch resets the master **WARNING** lights but does not deactivate the ground proximity warning.

Aural cautions are accompanied by ground proximity light illumination. The master **CAUTION** lights do not illuminate for ground proximity cautions.

GPWS Callouts

GPWS provides a voice callout at selected radio altitudes to advise the flight crew of the approximate height above ground level. Voice callouts are provided at:

- 100 feet – “ONE HUNDRED”
- 50 feet – “FIFTY”
- 30 feet – “THIRTY”
- 20 feet – “TWENTY”
- 10 feet – “TEN”

Look – Ahead Terrain Alerting

The look-ahead terrain feature of the GPWS shows computer generated terrain data on the navigation display.

- Terrain is displayed as the following:
 - Terrain more than 2000 feet below the aircraft is not displayed,
 - Terrain from 2000 feet below to 500 feet (250 feet with gear down) below the aircraft's current altitude is displayed as dotted green,
 - Terrain 500 feet (250 feet with gear down) below to 2000 feet above the aircraft's current altitude is displayed as dotted amber,
 - Terrain more than 2000 feet above the aircraft is displayed as dotted red,
 - The display is magenta if there is no terrain data available.

The terrain display is generated from a data base contained in the GPWS computer and correlated to the GPS position.

The terrain data is selected with the EFIS control panel terrain (TERR) map switch and displayed with the following navigation modes: expanded MAP, center MAP, expanded VOR and expanded APP. A cyan **TERR** annunciation appears on the navigation display when the terrain display is selected and is active. In the PLN, center VOR, and center APP modes, the TERR switch arms the terrain display. The terrain data is then immediately displayed when expanded MAP, center MAP, expanded VOR or expanded APP mode is selected.

The terrain function is disabled with the ground proximity terrain (TERR) override switch. A **TERR OVRD** annunciation appears on the navigation display and the EICAS advisory message **TERR OVRD** displays. If the system cannot determine aircraft position, the EICAS advisory message **TERR POS** displays.

Terrain cannot be displayed together with weather radar. Each pilot's display, however, is independent, permitting one pilot to display terrain and the other to display weather radar. All other displays (TCAS, LNAV routing, etc.) can be shown with terrain data.

The GPWS terrain data base contains detailed terrain data near major airports, and in lesser detail for areas between airports. The terrain data is useful to determine known terrain within 2000 feet of aircraft altitude, but is not designed to be an independent navigation aid.

There are three look-ahead terrain alerts:

- Look-ahead caution alert
- Look-ahead warning alert
- Terrain floor clearance alert.

The caution and warning alerts are based on a projected impact using the aircraft's flight path and ground speed.

A look-ahead caution terrain alert is initiated approximately 40-60 seconds from projected impact.

A look-ahead warning terrain alert is initiated approximately 20-30 seconds from projected impact.

The terrain data is automatically displayed with the first look-head terrain alert if neither pilot has the terrain display selected, and in expanded MAP, center MAP, expanded VOR or expanded APP modes. The terrain display replaces the weather radar display, and the cyan **TERR** annunciation appears on the navigation display.

The terrain clearance floor alert provides a terrain clearance envelope around the airport runway. It compliments the basic GPWS unsafe terrain clearance alert by providing alerts based on insufficient terrain clearance even when the aircraft is configured for landing. The system, however, does not access the FMC route of flight and cannot differentiate between destination airports and other nearby airports.

Look-Ahead Terrain Alerting Annunciations

Aural Alert	Visual Alert	Description
“CAUTION TERRAIN, CAUTION TERRAIN”	Amber TERRAIN on ND (all modes). GND PROX light	The threatening terrain ahead of the aircraft and 90 degrees of the current ground track becomes solid amber on the navigation display (in expanded MAP, center MAP, and expanded VOR or APP modes only).
“TERRAIN, TERRAIN”	Red PULL UP on PFD. Red TERRAIN on ND (all modes). Master WARNING lights.	The threatening terrain ahead of the airplane and 90 degrees of the current aircraft ground track becomes a solid red on the navigation display (in expanded MAP, center MAP, and expanded VOR or APP modes only).
“TOO LOW TERRAIN”	Red PULL UP on PFD.	The terrain clearance floor alert is based on aircraft location, nearest runway center point, and radio altitude.

Weather Radar / Predictive Windshear System

Weather Radar

The weather radar system consists of two receiver-transmitter units, an antenna, and a control panel. Radar returns are shown on the navigation display (ND) in all modes except:

- Plan
- VOR center
- Approach center.

The EFIS control panel weather radar (WXR) map switch controls power to the transmitter/receiver and controls the weather radar display on the ND. The radar display range automatically adjusts to the ND range selected on the EFIS control panel.

The CDU can control the EFIS control panel functions, including the WXR. The weather radar operating modes and fault conditions are shown on the ND.

Turbulence can be sensed by the weather radar only when there is sufficient precipitation. Clear air turbulence can not be sensed by radar.

The weather radar also provides predictive windshear alerting.

Predictive Windshear System

The Predictive Windshear System (PWS) is part of the weather radar system.

It augments the GPWS windshear detection system. The PWS uses radar imaging to detect disturbed air prior to entering a windshear. Aural and visual alerts warn the crew of windshear. The PWS is activated by the following methods:

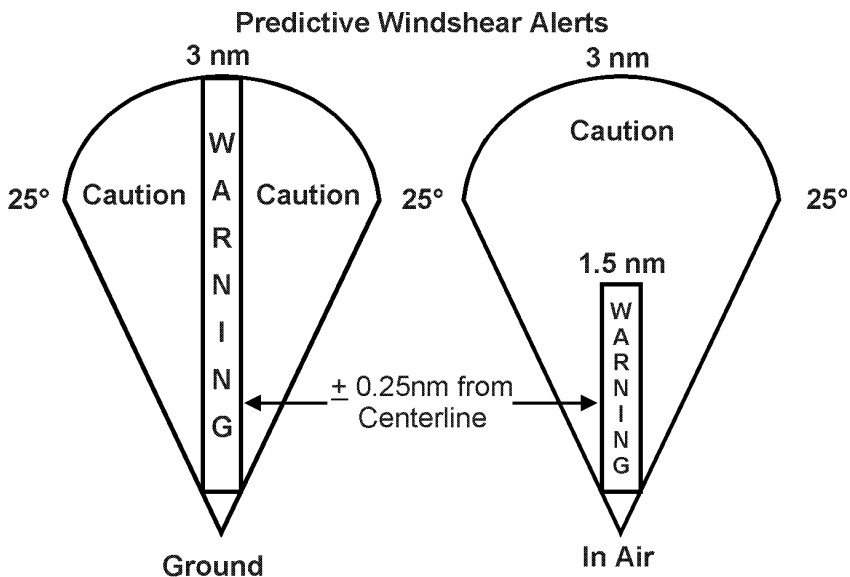
- Manually on the ground when the weather radar is activated with the EFIS control panel WXR switch,
- Automatically on the ground when the thrust levers are set for takeoff,
- Automatically in the air when below 2300 feet AGL.

There are two alerts associated with the PWS: a warning alert and a caution alert. These alerts are available below 1200 feet RA.

A PWS caution windshear alert is activated if a windshear is detected between 0.5 and 3 nm and 25 degrees left or right of the aircraft's magnetic heading, and not within the warning alert area.

On the ground, a PWS warning alert is activated if a windshear is detected between 0.5 nm and 3 nm and 0.25 nm right or left of the aircraft's magnetic heading.

In the air, a PWS warning alert is activated if a windshear is detected between 0.5 and 1.5 nm and 0.25 nm left or right of the aircraft's magnetic heading.



Predictive Windshear Annunciations

Aural Alert	Visual Alert	Description
“MONITOR RADAR DISPLAY”	Red PWS symbol on ND (in expanded MAP, center MAP, and expanded VOR or APP modes only). Amber WINDSHEAR on ND (all modes).	Caution alert.
“WINDSHEAR AHEAD”	Red WINDSHEAR on PFD. Red PWS symbol on ND (in expanded MAP, center MAP, and expanded VOR or APP modes only). Red WINDSHEAR on ND (all modes).	Takeoff warning.
“GO AROUND, WINDSHEAR AHEAD”	Red WINDSHEAR on PFD. Red PWS symbol on ND (in expanded MAP, center MAP, and expanded VOR or APP modes only). Red WINDSHEAR on ND (all modes).	Approach warning.

During takeoff and landing, the PWS inhibits new caution alerts between 80 knots and 400 feet AGL, and new warning alerts between 100 knots and 50 feet AGL. These inhibits do not remove existing caution or warning alerts.

PWS windshear alerts are prioritized along with GPWS and TCAS alerts based on the level of the hazard and time required for flight crews to react. The GPWS windshear warning is the highest level, followed by terrain warnings, predictive windshear, and TCAS.

Weather Radar / Predictive Windshear System Test Procedures**Test**

The Weather Radar (WXR) and Predictive Windshear System (PWS) are not required to be tested by the B777 flight crew. Any discrepancies effecting operation of either system is annunciated on EICAS. If a test of the WXR / PWS systems is desired the following procedure applies:

Weather Radar / Predictive Windshear Test

The B777 Radar / Predictive Windshear system requires a two phase test:

WXR Test:

TEST Button (WX RDR Panel)SELECT

WXR Button (EFIS Control Panel) PUSH (ON)

Indications on ND:

Test Pattern

WXR TEST message (amber)

PWS Test:

TEST Button (WX RDR Panel) Deselect

TEST Button (WX RDR Panel)SELECT

First 2 seconds:

Visual Indications:

WINDSHEAR message on ND (amber)

Aural announcement:

“MONITOR RADAR DISPLAY”

After 10 seconds:

Visual Indications:

WINDSHEAR message on ND (red)

WINDSHEAR message on PFD (red)

Master **WARNING** lights on glareshield (red)

WINDSHEAR SYS advisory on EICAS

Aural announcement:

“GO AROUND, WINDSHEAR AHEAD”

- pause -

“WINDSHEAR AHEAD, WINDSHEAR AHEAD”

(Continued)

WXR Button (EFIS Control Panel)PUSH (OFF)

TEST Button (WX RDR Panel) DESELECT

Selecting TEST mode selects the test mode for both the left and right ND's. Depressing the **WXR** pushbutton on the EFIS control panel activates the weather radar test mode. Depressing the **WXR** pushbutton a second time deactivates the radar. When the test is completed select desired mode.

During the test mode the following occurs:

The transmitter is enabled for less than one second and then muted for the remaining portion of the test.

The ND displays a test pattern containing a four color pattern of centric arcs, turb wedges and a windshear icon.

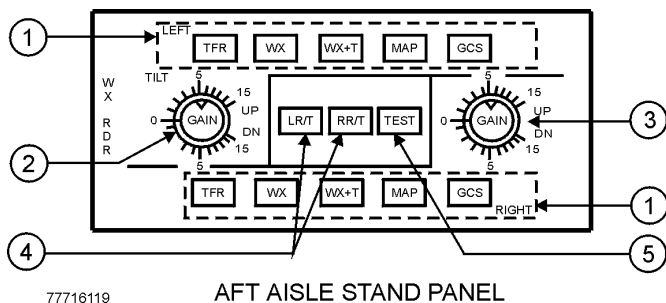


7773017

The antenna system performs a test sequence, ending with the antenna stopping at the boresight (electrical zero) position.

Note: The windshear detection mode is automatically activated if the radio altimeter reports an altitude less than 2300 feet and the aircraft “windshear active” qualifiers are valid.

Weather Radar Panel



① Weather Radar Mode Switches

PUSH – selects mode

LEFT – controls displays on left ND

RIGHT – controls displays on right ND

TFR (transfer) - transfers other ND display selections to related ND

WX – shows weather radar returns at calibrated gain level

WX+T (turbulence) – shows weather returns and turbulence within precipitation at calibrated gain level. Turbulence display is available on displays of 40 miles or less.

Note: Turbulence detection requires presence of detectable precipitation. Clear air turbulence cannot be detected by radar.

MAP – shows ground returns at selected gain level

GCS (ground clutter suppression)

- IN – reduces amount of ground returns
- OUT – shows ground returns

Note: Continuous operation is not recommended because weather return intensity may be reduced.

② GAIN Control

Rotate inner knob – Sets receiver sensitivity in WX, WX+T, and MAP modes on related ND.

The ∇ symbol reflects the amount of gain selected as follows:

- 12 o'clock detent – auto gain (no gain indication on lower left side of MAP display).
- Full counter clockwise – minimum manual gain (VAR displayed on lower left side of MAP display).
- Full clockwise – maximum manual gain (VAR displayed on lower left side of MAP display)

③ Tilt Control

Rotate knob clockwise – tilts radar antenna up

Rotate knob down – tilts radar antenna down

④ Receiver/Transmitter Switches

Push:

- LR/T (left receiver/transmitter) – selects left weather radar system. Pushes out RR/T (right receiver/transmitter) switch.
- RR/T – selects right weather radar system. Pushes out LR/T switch.

⑤ TEST Switch

Push:

- Test selected transmitter without radiating.
- Shows test pattern and any fault message on ND with WXR selected (except in PLAN, CTR VOR and CTR APP modes).

Note: If the airplane is on the ground and the thrust levers are not advanced for takeoff, the WXR tests the Predictive Windshear System (PWS) indications. These include the WINDSHEAR SYS EICAS advisory, the PWS caution and PWS warning. Deactivating WXR on the EFIS control panel will discontinue the test. The PWS test lasts approximately 15 seconds.

TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS-7)

TCAS alerts the crew to possible conflicting traffic. TCAS interrogates operating transponders in other aircrafts, tracks the other aircrafts by analyzing the transponder replies, and predicts the flight paths and positions. TCAS provides advisory, flight path guidance, and traffic displays of the other aircrafts to the flight crew. Neither advisory, guidance, nor traffic display is provided for other aircrafts that do not have operating transponders. TCAS operation is independent of ground-based air traffic control.

To provide advisories, TCAS identifies a three-dimensional airspace around the aircraft where a high likelihood of traffic conflict exists. The dimensions of this airspace are contingent upon the closure rate with conflicting traffic.

TCAS provides advisories and traffic displays:

- Resolution Advisory (RA) and display
- Traffic Advisory (TA) and display
- Proximate traffic display
- Other traffic display.

TCAS messages and TCAS traffic symbols can be displayed on the ND in the map, map centered, VOR, and approach modes. TCAS messages and TCAS traffic symbols cannot be displayed on the ND in the VOR-centered, approach-centered, or plan modes. **TRAFFIC**, **TA ONLY**, and **TCAS TEST** are displayed in all EFIS modes.

Resolution Advisories (RA) and Display

An RA is a prediction that another aircraft will enter the TCAS conflict airspace within approximately 20 to 30 seconds. If altitude data from the other aircraft is not available, no RA can be provided.

When the TCAS issues an RA:

- TCAS voice alert sounds
- TCAS vertical guidance is displayed on the PFD
- TCAS vertical guidance is displayed on the vertical speed indication
- The TCAS red message **TRAFFIC** is displayed on the ND.

When the TCAS cyan message **TFC** is displayed on the ND, and the RA is within the display range of the ND, the TCAS RA traffic symbol and its accompanying data tag is displayed on the ND. The TCAS RA traffic symbol is a filled red square.

For no-bearing RAs, the red RA label is displayed below the red message, **TRAFFIC**, and the RA data tag information is displayed to the right of the label. The RA red data tag contains the distance, altitude, and the vertical motion arrow.

When the RA is further from the aircraft than the ND range currently displayed, the TCAS red message **OFFSCALE** is displayed on the ND.

Traffic Advisories (TA) and Display

A TA is a prediction that another aircraft will enter the conflict airspace in 35 to 45 seconds. TAs are provided to assist the flight crew in establishing visual contact with the other aircraft.

When TCAS predicts a TA:

- The TCAS voice alert “TRAFFIC, TRAFFIC” sounds once
- The TCAS amber message **TRAFFIC** is displayed on the ND.

When the TCAS cyan message **TFC** is displayed on the ND and the TA is within the display range of the ND, the TCAS TA traffic symbol and its accompanying data tag are displayed on the ND. The TA traffic symbol is a filled amber circle.

For no-bearing TAs, the amber TA label is displayed below the **TRAFFIC** message, and the TA data tag information is displayed to the right of the label. The TA labels are displayed below the RA labels. The TA data tag contains the distance, altitude, and vertical motion arrow.

When the TA is further from the aircraft than the ND range currently displayed, the TCAS amber message **OFFSCALE** is displayed on the ND.

Proximate Traffic Display

Proximate traffic is another aircraft that is neither an RA or a TA but is within:

- Six miles
- 1,200 feet vertically.

When the TCAS cyan message **TFC** is displayed on the ND and the proximate traffic is within the ND display range, the TCAS proximate traffic symbol is displayed on the ND. The TCAS proximate traffic symbol is a filled white diamond. If the other aircraft is providing altitude data, then a data tag is also displayed that contains this information about the other aircraft:

- The relative or absolute altitude
- The climbing or descending vertical direction.

Other Traffic Display

Other traffic is another aircraft that is within the ND display limits but is neither an RA, a TA, or proximate traffic. If the other aircraft is not providing altitude information, other traffic becomes proximate traffic automatically when within six miles.

When the TCAS cyan message **TFC** is displayed on the ND and the other traffic is within the ND display range, then the TCAS other traffic symbol is displayed on the ND. The TCAS other traffic symbol is a hollow white diamond. If the other aircraft is providing altitude data, then a data tag like that described in the proximate traffic display is displayed.

TCAS Voice Alerts

The TCAS voice alert “TRAFFIC, TRAFFIC” sounds once when TCAS first predicts a new TA.

When TCAS first predicts a new RA, one of the following TCAS voice alerts sounds once:

- “MONITOR VERTICAL SPEED”
- “MAINTAIN VERTICAL SPEED, MAINTAIN”
- “MAINTAIN VERTICAL SPEED, CROSSING MAINTAIN”
- “CLIMB, CLIMB”
- “CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB”
- “DESCEND, DESCEND”
- “DESCEND, CROSSING DESCEND, DESCEND, CROSSING DESCEND.”

Crossing alerts are provided when the aircraft will fly through the altitude of the other aircraft when following the TCAS vertical guidance on the PFD.

If TCAS requires an increase or decrease in the vertical rate of climb, then one of the following TCAS voice alerts sounds once:

- “INCREASE CLIMB, INCREASE CLIMB”
- “INCREASE DESCENT, INCREASE DESCENT”
- “ADJUST VERTICAL SPEED, ADJUST.”

If TCAS requires a change in vertical direction from either an existing climb to a descent, or an existing descent to a climb, then one of the following TCAS voice alerts sounds once:

- “DESCEND, DESCEND NOW, DESCEND, DESCEND NOW”
- “CLIMB, CLIMB NOW, CLIMB, CLIMB NOW.”

When separation from the other aircraft is increasing and TCAS predicts there will be no RA, the TCAS voice alert “CLEAR OF CONFLICT” sounds once. However, the alert will not sound if the RA can no longer be calculated because TCAS cannot predict the track of the other aircraft.

The following are the available TCAS voice alerts:

Voice Alert	Type	Response
“TRAFFIC, TRAFFIC”	TA	Attempt to visually locate the traffic.
“MONITOR VERTICAL SPEED”	RA	Present pitch attitude is within the TCAS PFD vertical guidance pitch command. Keep pitch attitude away from the red pitch command.
“MAINTAIN VERTICAL SPEED, MAINTAIN”	RA	Present pitch attitude is within the TCAS PFD vertical guidance pitch command. Continue to keep pitch attitude away from the red pitch command. Aircraft will pass through the altitude of the traffic.
“MAINTAIN VERTICAL SPEED CROSSING, MAINTAIN”	RA	Climb as directed by TCAS PFD vertical guidance.
“CLIMB, CLIMB”	RA	Climb as directed by TCAS PFD vertical guidance.
“CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB”	RA	Climb as directed by TCAS PFD vertical guidance. Aircraft will climb through the altitude of the traffic.
“DESCEND, DESCEND”	RA	Descend as directed by TCAS PFD vertical guidance.
“DESCEND, CROSSING DESCEND, DESCEND, CROSSING DESCEND”	RA	Descend as directed by TCAS PFD vertical guidance. Aircraft will descend through the altitude of the traffic.
“INCREASE CLIMB, INCREASE CLIMB”	RA	Present pitch attitude is within TCAS PFD vertical guidance pitch command. Keep pitch attitude out of red pitch command.
“INCREASE DESCENT, INCREASE DESCENT”		
“ADJUST VERTICAL SPEED, ADJUST”		

“DESCEND, DESCEND NOW, DESCEND, DESCEND NOW”	RA	Descend as directed by TCAS PFD vertical guidance. Previous TCAS vertical guidance was to climb.
“CLIMB, CLIMB NOW, CLIMB, CLIMB NOW”	RA	Climb as directed by TCAS PFD vertical guidance. Previous TCAS vertical guidance was to descend.
“CLEAR OF CONFLICT”	RA	Separation is increasing and the RA will not occur. Vertical guidance is removed from the PFDs and traffic changes to a TA symbol.

TCAS PFD Vertical Guidance

When TCAS predicts an RA, TCAS vertical guidance is displayed on the PFD for a maneuver to ensure vertical separation. The pitch maneuver is based on traffic aircraft altitude information.

If the traffic aircraft also has TCAS and a mode S transponder, TCAS vertical guidance is coordinated with the traffic aircraft TCAS.

TCAS PFD Vertical Speed Indication RA Guidance

When TCAS predicts an RA, TCAS vertical guidance is also displayed on the vertical speed indication for a maneuver to ensure vertical separation.

TCAS ND Messages

The ND TCAS red message **TRAFFIC** is displayed when TCAS predicts an RA.

The cyan message **TFC** is displayed when TCAS traffic symbols and messages are or can be displayed. The message is not displayed if the TCAS message **TCAS FAIL**, **TCAS OFF**, or **TCAS TEST** is displayed.

The amber message **TRAFFIC** is displayed when TCAS predicts a TA.

The red message **OFFSCALE** is displayed when TCAS predicts an RA that is at a distance greater than the ND selected range.

The amber message **OFFSCALE** is displayed when TCAS predicts a TA (but not an RA) that is at a distance greater than the ND selected range.

When the cyan message **TA ONLY** is displayed, TCAS can not provide RAs. All other traffic that would have been RAs are predicted as TAs.

The cyan message **TCAS TEST** is displayed when TCAS is in the test mode. The message is displayed on all ND modes and ranges.

The amber message **TCAS FAIL** is displayed if TCAS is failed, or TCAS information cannot be displayed on the ND.

The amber message **TCAS OFF** is displayed if the **TRAFFIC** switch is pushed to display traffic, but TCAS is not selected on the transponder panel.

TCAS Inhibits

INCREASE DESCENT RAs are inhibited below 1,450 feet radio altitude.

DESCEND RAs are inhibited below 1,000 feet radio altitude when descending, and below 1,200 feet radio altitude when climbing.

All RAs are inhibited below 1,100 feet radio altitude when climbing and below 900 feet radio altitude when descending.

TCAS voice alerts are inhibited below 500 feet radio altitude.

All TCAS alerts are inhibited by GPWS and windshear warnings.

TCAS Normal Operation

The TCAS operating mode is controlled from the transponder panel. TCAS is normally operated in the TA/RA mode. However, sometimes it is necessary to operate in the TA ONLY mode to prevent nuisance RAs.

The TA ONLY mode is used during engine out operations to prevent RAs when adequate thrust is not available to follow the RA commands. Also, the TA ONLY mode can be used when intentionally operating near other traffic that may cause RAs, such as during parallel approaches and VFR operations.

TCAS Non-Normal Operation

The EICAS advisory message **TCAS OFF** is displayed if TCAS is not operating. No TCAS RA guidance is displayed on the PFDs, no TCAS traffic symbols are displayed on the NDs, and no TCAS voice alerts sound. An amber **TCAS OFF** message is displayed on both NDs.

The EICAS advisory message **TCAS RA (CAPTAIN or F/O)** is displayed if TCAS cannot display RA guidance on the respective PFD. The ND traffic displays and voice alerts are unaffected.

The EICAS advisory message **TCAS** is displayed if TCAS cannot display TCAS RA guidance on either PFD, and cannot display TCAS traffic symbols on either ND. TCAS voice alerts will not occur. An amber **TCAS FAIL** message is displayed on both NDs.

CREW ALERTNESS MONITOR

The FMC continuously monitors the activation of switches on the mode control panel, EFIS control panel, display select panel, CDUs, and VHF/HF push-to-talk (PTT) switches. When a predefined time elapses after the last control activation, the EICAS advisory message **PILOT RESPONSE** is generated.

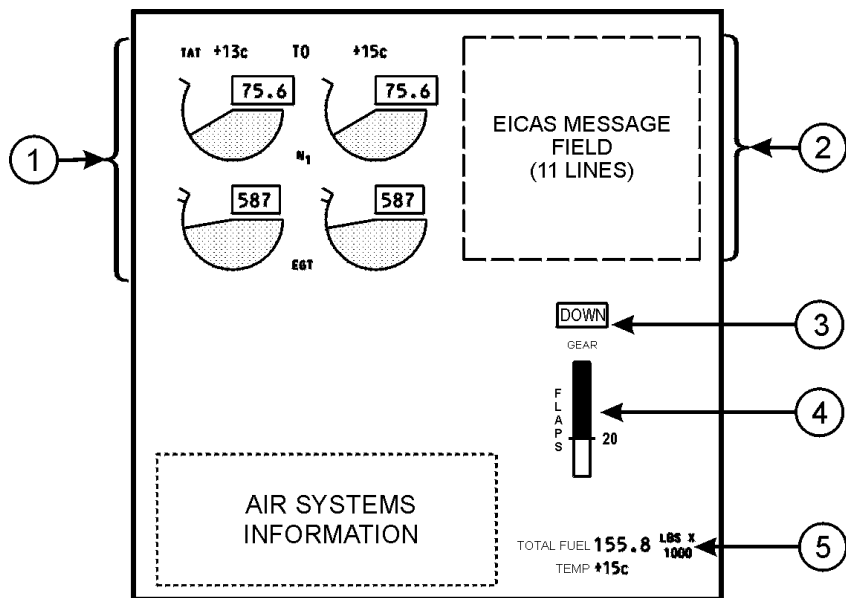
The **PILOT RESPONSE** message can be cleared by pushing any control on any of the monitored systems or panels. If there is still no response after a short time, the EICAS caution message **PILOT RESPONSE** is displayed. If there is still no response, the warning message **PILOT RESPONSE** is displayed. Any control activation on the MCP, EFIS control panel, display select panel, CDUs, or VHF/HF transmitters resets the **PILOT RESPONSE** message. The **PILOT RESPONSE** message is inhibited at all altitudes below 20,000 feet while the aircraft is in a climb and the flaps are not up.

Tail Strike Indication

The tail strike indication system detects ground contact which could damage the aircraft pressure hull. The system consists of a two inch blade target and two proximity sensors, and is installed on the aft body of the aircraft. The EICAS caution message **TAIL STRIKE** is displayed.

CONTROLS AND INDICATORS

ENGINE INDICATION AND CREW ALERTING SYSTEM (EICAS)



EICAS DISPLAY

7772002

① Primary Engine Indications

Displayed full time on the EICAS display.

② EICAS Message Field

Eleven lines are available for system alerts, communications alerts, and memo messages.

Additional pages are available.

③ GEAR Position Indication

Appears automatically when the landing gear are not up and locked.

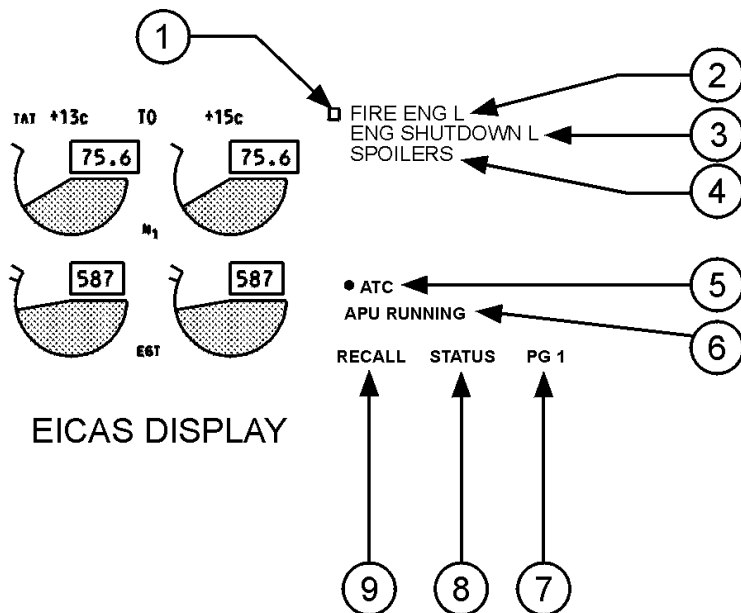
④ FLAPS Position Indication

Appears automatically when the flaps are not retracted.

⑤ Fuel Quantity Indications

Displays total fuel quantity and fuel temperature.

Displays individual tank quantities for non-normal conditions.



7772003

EICAS MESSAGES

① Checklist Icon

Displayed (white):

- If a checklist exists for the indicated message
- Disappears when the checklist is complete.

② Warning Messages

Displayed (red) - The highest priority alert messages.

③ Caution Messages

Displayed (amber) - The next highest priority alert messages after warning messages.

④ Advisory Messages

Displayed (amber):

- The lowest priority alert messages
- Indented one space.

⑤ Communication Messages

Displayed (white):

- Indicates incoming communication messages
- Preceded by a white dot
- COMM low messages are indented one space.

⑥ Memo Messages

Displayed (white) - A reminder of the current selected state of controls/systems.

⑦ Page (PG) Number

In view:

- More than one page of alert or memo messages exists
- Indicates the number of the page selected.

⑧ **STATUS** Cue

Displayed when a new status message exists.

Removed when the status page is displayed.

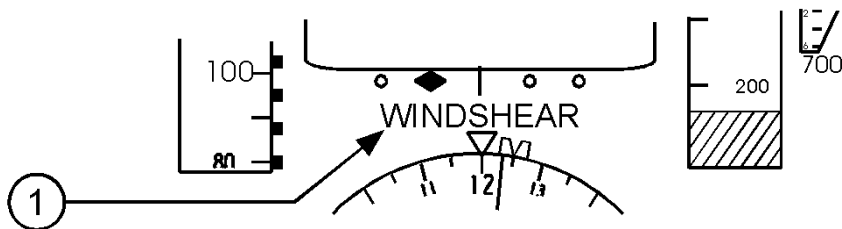
⑨ **RECALL** Indication

Displayed when the CANCEL/RECALL switch is pushed.

Remains displayed for one second after the switch is released.

INTENTIONALLY LEFT BLANK

SYSTEM WARNINGS



PRIMARY FLIGHT DISPLAY (PFD)

7772004

TIME CRITICAL WARNINGS (PFD)

① Time Critical Warnings

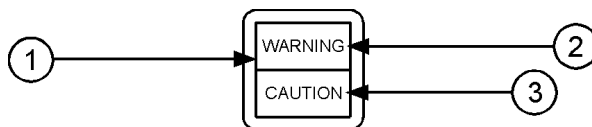
WINDSHEAR (red):

- A windshear condition is detected
- All other GPWS modes are inhibited.

PULL UP (red):

- The GPWS barometric descent rate is excessive, or
- The GPWS radio altitude decrease rate is excessive.

ENG FAIL (red) - the left or right engine has failed (between 65 knots and slightly less than V_1).



GLARESHIELD PANEL

7772005

MASTER WARNING / CAUTION RESET SWITCHES AND LIGHTS

- ① Master WARNING/CAUTION Reset Switch

Push -

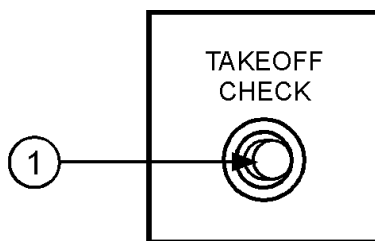
- Extinguishes the master **WARNING** lights
- Extinguishes the master **CAUTION** lights
- Silences most associated aural alerts (for exceptions, see Section 6.15, Master Warning/Caution Reset Switches and Lights).

- ② Master **WARNING** Light

Illuminated (red) - A time critical warning or warning condition exists.

- ③ Master **CAUTION** Light

Illuminated (amber) - A caution condition exists.

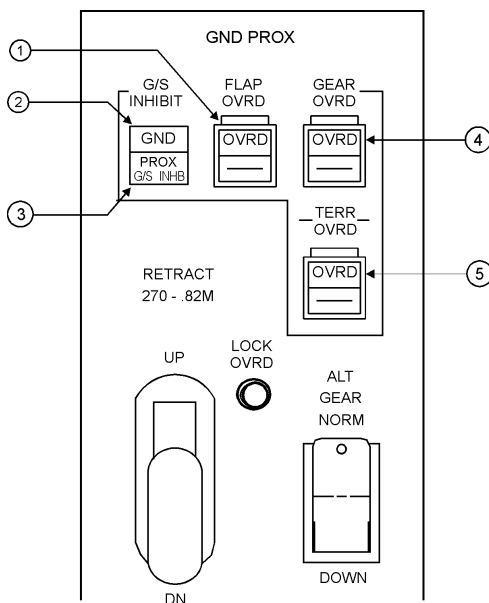
Takeoff Check Switch

FORWARD AISLE STAND

7772015

- ① TAKEOFF CHECK Switch

Push – Arms takeoff configuration warnings when on the ground and thrust is not in takeoff range.

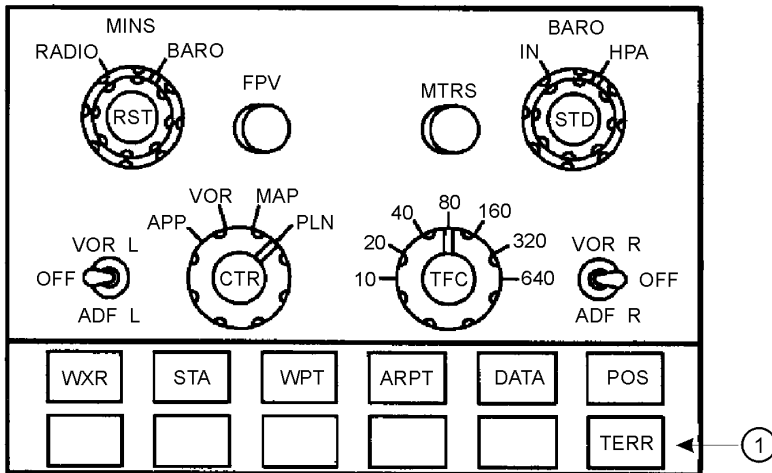


LANDING GEAR PANEL

GROUND PROXIMITY WARNING SYSTEM (GPWS) CONTROLS

- ① Ground Proximity FLAP Override Switch
Push (OVRD visible) – Inhibits the ground proximity “TOO LOW FLAPS” caution.
- ② Ground Proximity (GND PROX) Glideslope (G/S) Inhibit Switch
Push – Inhibits the ground proximity GLIDESLOPE caution when below 1,000 feet radio altitude.
- ③ Ground Proximity Light
PROX visible (amber) – A ground proximity caution exists.
- ④ Ground Proximity GEAR Override Switch
Push (OVRD visible) –
 - Inhibits the ground proximity “TOO LOW GEAR” caution
 - Inhibits the landing configuration warning siren.
- ⑤ Ground Proximity Terrain (TERR) Override Switch
Push (OVRD visible) – Inhibits operation of look-ahead terrain alerts, terrain clearance floor alert, and terrain display.

GPWS TERRAIN DISPLAY SELECT SWITCH



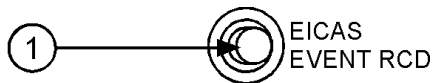
GLARESHIELD

7772010A

① Terrain (TERR) Display Select Switch

When selected:

- Displays terrain data in MAP, center MAP, expanded VOR and expanded APP modes.
- Arms terrain data in PLN, center VOR and center APP modes.
- Deselects the weather radar display regardless of the mode selector position.
- Second push removes information.



FORWARD AISLE STAND

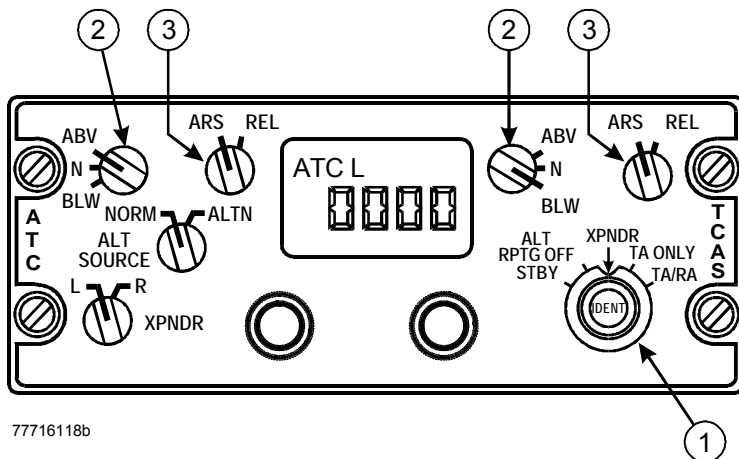
7772007

EICAS EVENT RECORD SWITCH

① EICAS Event Record (EVENT RCD) Switch

Push - records up to five EICAS events into memory.

TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS)



77716118b

AFT AISLE STAND TCAS CONTROLS (TRANSPONDER PANEL)

① Transponder Mode Selector TCAS Controls

TA ONLY - Allows the display of traffic advisory (TA) targets.

TA/RA - Allows the display of traffic advisory (TA) targets and resolution advisory (RA) targets with resolution advisory aural and PFD vertical guidance pitch command and vertical speed command.

② TCAS Airspace Selector

Note: The left selector controls the left TCAS display; the right selector controls the right TCAS display.

This selector controls the vertical display range of other traffic, and has no effect on the detection and display of proximate traffic, TAs, or RAs.

ABV - Altitude range is set to 7000 ft. above the aircraft, and 2700 ft. below the aircraft.

N - Altitude range is set to 2700 ft. above the aircraft, and 2700 ft. below the aircraft.

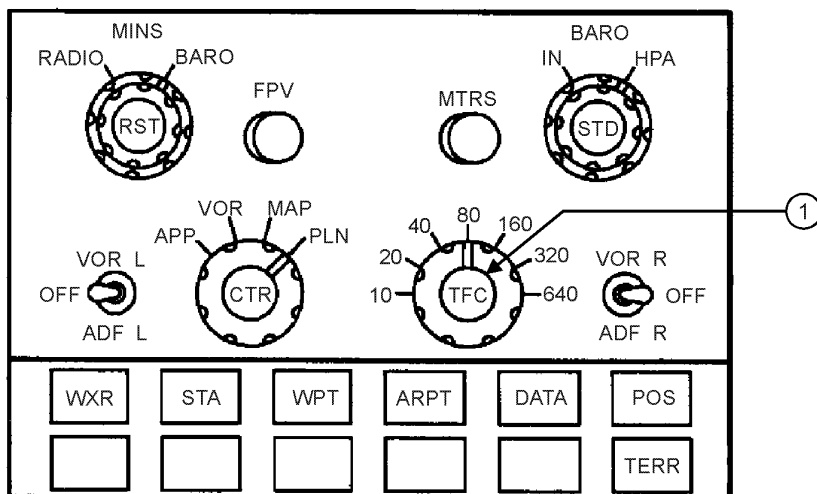
BLW - Altitude range is set to 2700 ft. above the aircraft, and 7000 ft. below the aircraft.

③ Absolute/Relative (ABS/REL) Altitude Selector

Note: The left selector controls the left TCAS display; the right selector controls the right TCAS display.

ABS (absolute) - Displays absolute altitude on the TCAS traffic display.

REL (relative) - Displays relative altitude (relative to own aircraft) on the TCAS traffic display.

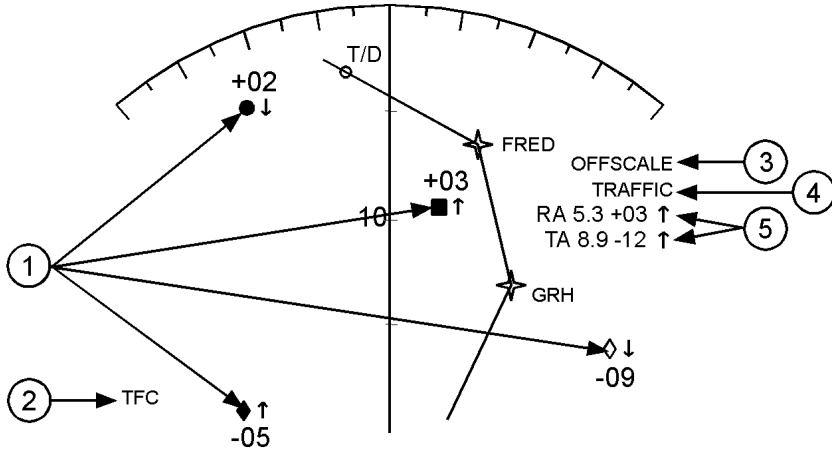


GLARESHIELD

7772010

① TFC – TCAS Display Select Switch

When selected allows TCAS traffic to be displayed on the ND.



ND

TCAS TRAFFIC DISPLAYS

7772008

① Traffic Targets

Indicates the relative position of traffic targets.

A filled red square indicates a Resolution Advisory (RA).

A filled amber circle indicates a Traffic Advisory (TA).

A filled white diamond indicates proximate traffic.

An unfilled white diamond indicates other traffic.

The number represents the relative or absolute altitude of the traffic in hundreds and thousands of feet; a missing number indicates the altitude is unknown.

The arrow indicates whether the traffic is climbing or descending at a rate of 500 feet per minute or greater; a missing arrow means the traffic is flying relatively level.

Displayed only when TCAS is enabled.

② TCAS Mode Annunciations

TFC - TCAS is enabled.

TA ONLY - all TAs and RAs are processed and displayed as TAs.

TCAS is:

- Turned on by selecting TA/RA or TA ONLY on the transponder panel
- Enabled by pushing the EFIS control panel TFC switch
- Displayed in MAP, MAP CTR, APP and VOR modes.

③ **OFFSCALE** Message

Indicates a TCAS RA or TA is beyond the selected map range.

Displayed only if TCAS is enabled.

④ **TRAFFIC** Alert Message

Displayed whenever a TCAS RA or TA is active.

Displayed whether TCAS traffic information is being displayed or not.

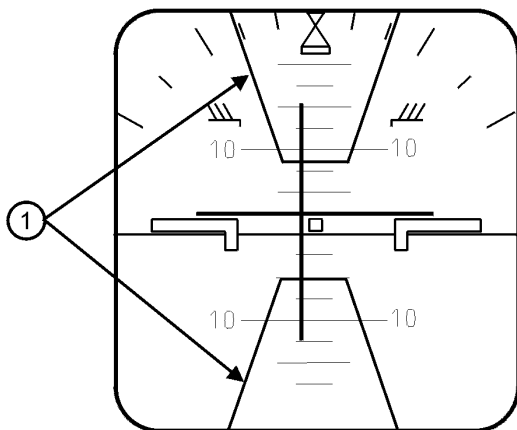
Displayed in all ND modes and ranges.

⑤ TCAS No Bearing Messages

Expanded description of RAs and TAs with no associated bearing.

The message provides traffic type, range in NM, altitude and vertical direction.

Displayed only when TCAS is enabled.



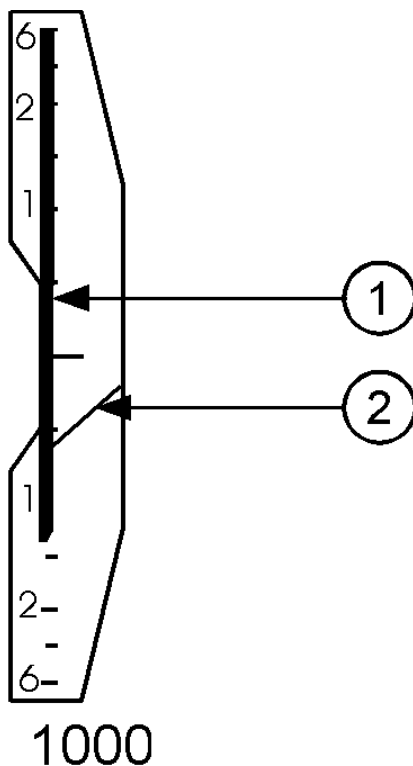
7772009a

PFD**TCAS PITCH COMMANDS**

- ① Traffic Alert and Collision Avoidance System (TCAS) Pitch Command (Red)

Note: For a single RA, only one of the TCAS pitch commands (above or below) is visible at a time. For two or more RAs, two pitch commands may be displayed.

The area inside the red pitch command lines indicates the pitch region to avoid in order to resolve the traffic conflict. The center of the aircraft symbol must be outside the TCAS pitch command area to ensure traffic avoidance.



PFD

77720010

TCAS VERTICAL SPEED COMMANDS

- ① TCAS Resolution Advisory Vertical Speed Command

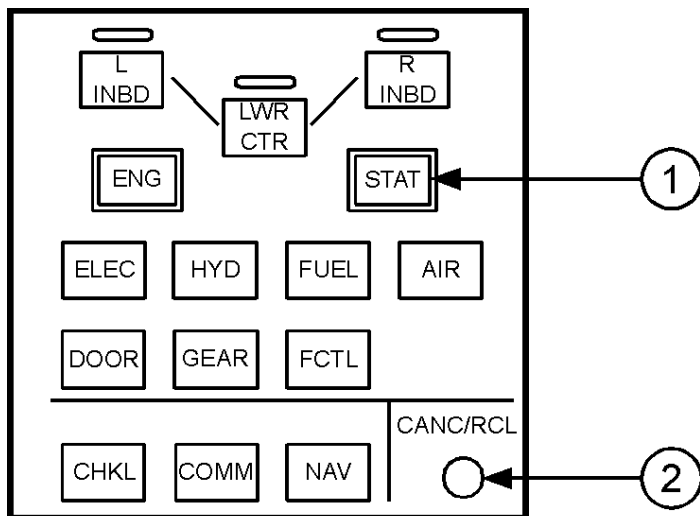
The red bar indicates vertical speeds that must be avoided in order to resolve a traffic conflict. In this example, a descending vertical speed of 1500 feet or more avoids the traffic.

- ② Vertical Speed Pointer

Red - Vertical speed is inside the area of conflict.

White - Vertical speed is outside the area of conflict.

DISPLAY SELECT PANEL



GLARESHIELD

77720011

① Status (STAT) Display Switch

Push - Displays the status display on the selected MFD.

Subsequent pushes -

- Displays the next page of status messages when additional pages exist
- The lower center MFD blanks after the last page of status messages is displayed
- The inboard MFDs return to the NAV display after the last page of status messages is displayed.

② Cancel/Recall (CANC/RCL) Switch

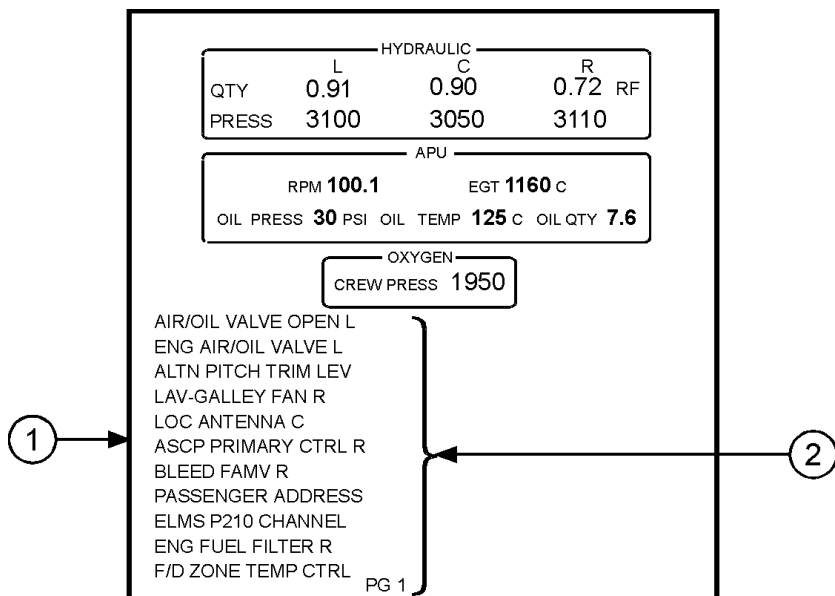
Push (when there are EICAS caution or advisory messages displayed) -

- Displays the next page of EICAS messages when additional pages exist
- Cancels caution and advisory messages when the last page is displayed (warning, memo and communications messages remain).

Pushing this switch cancels the red box color of any engine parameter exceedance box that remains after a red line exceeded parameter has cleared.

Pushing this switch when there are no EICAS messages displayed:

- Displays the previously cancelled EICAS messages, if the condition(s) still exist
- Displays the first page of messages when multiple pages exist
- Displays previously canceled red exceedance boxes.



MULTIFUNCTION DISPLAY

77720012

STATUS DISPLAY

① Status Display

Displays hydraulic, APU, and oxygen system indications and status messages.

② Status Messages

Status messages indicate conditions requiring MEL reference for dispatch.

A page number appears if additional pages of status messages exist.

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WARNING SYSTEMS EICAS MESSAGES

The following EICAS messages can be displayed.

Altitude Alert and GPWS

Message	Level	Aural	Condition
ALTITUDE ALERT	Caution	Beeper	Aircraft has deviated from the selected altitude.
ALTITUDE CALLOUTS	Advisory		Altitude callouts are no longer provided.
GND PROX SYS	Advisory		Ground proximity alerts may not be provided.
TERR POS	Advisory		Terrain position data has been lost.
TERR OVRD	Advisory		Ground proximity terrain override switch is in OVRD. Look-ahead terrain alerts and the terrain display are not provided.
WINDSHEAR SYS	Advisory		Windshear alerts may not be provided.

Configuration

Message	Level	Aural	Condition
CONFIG DOORS	Warning	Siren	A door is not closed, latched, and locked when either engine's thrust is in the takeoff range on the ground.
CONFIG FLAPS	Warning	Siren	Flaps are not in a takeoff position when either engine's thrust is in the takeoff range on the ground.
CONFIG GEAR	Warning	Siren	Any landing gear is not down and locked when either thrust lever is closed below 800 feet radio altitude or when flaps are in a landing position.
CONFIG GEAR STEERING	Warning	Siren	Main gear steering is unlocked when either engine's thrust is in the takeoff range on the ground.
CONFIG PARKING BRAKE	Warning	Siren	Parking brake is set when either engine's thrust is in the takeoff range on the ground.
CONFIG RUDDER	Warning	Siren	Rudder trim is not centered when either engine's thrust is in the takeoff range on the ground.
CONFIG SPOILERS	Warning	Siren	Speedbrake lever is not DOWN when either engine's thrust is in the takeoff range on the ground.
CONFIG STABILIZER	Warning	Siren	Stabilizer is not within the greenband when either engine's thrust is in the takeoff range on the ground.
CONFIG WARNING SYS	Advisory		A fault is detected in the configuration warning system.

TCAS

Message	Level	Aural	Condition
TCAS	Advisory		TCAS has failed.
TCAS OFF	Advisory		TCAS is not operating.
TCAS RA CAPTAIN, F/O	Advisory		TCAS cannot display RA guidance on the affected PFD.

Miscellaneous

Message	Level	Aural	Condition
OVERSPEED	Warning	Siren	Airspeed has exceeded Vmo/Mmo.
TAIL STRIKE	Caution	Beeper	A tail strike has been detected.
AIRSPPEED LOW	Caution	Beeper	Airspeed is below minimum maneuvering speed.
PILOT RESPONSE	Advisory		Predefined time elapsed since pilot activation of switches on the MCP, DSP, CDU, EFIS, control panel, and VHF/HF PTT.
PILOT RESPONSE	Caution	Beeper	No response after a short time since PILOT RESPONSE Advisory.
PILOT RESPONSE	Warning	Siren	No response after a short time since PILOT RESPONSE Caution.

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FUEL

Sec. 6.12 LEP-2

Rev. 11/01/02 #9

Continental

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Flight Manual

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AIR SYSTEMS DESCRIPTION

AIR CONDITIONING SYSTEM

Introduction

The air conditioning system supplies conditioned bleed air and recirculated cabin air at a controlled temperature throughout the airplane.

The system supplies conditioned air to the flight deck shoulder heaters.

The system supplies ventilation for the passenger cabin lavatories and galleys, and for the flight deck crew rest compartment.

Pack control, zone temperature control, cabin air recirculation, fault detection, and overheat protection are all automatic. Backup system control modes operate automatically in the event of system failures.

The airplane is divided into seven temperature zones: The flight deck and six passenger cabin zones.

Air Conditioning Packs

Two identical air conditioning packs cool bleed air from the engines, APU, or high pressure air from a ground source. Bleed air is pre-cooled before entering the pack. The packs are controlled by two identical pack controllers. If a controller fails, pack control switches automatically to the other controller. Pack output is automatically increased during high pack demand periods (to compensate for a failed pack or recirculation fan), or limited during high bleed air demand periods (such as for gear retraction during takeoff).

Pack Ground Operation

Both air conditioning packs are normally selected to AUTO for ground operations. Single pack operation is not recommended as a normal procedure. Single pack operation does not reduce APU fuel consumption. Single pack operation also causes higher flight line noise levels.

When a source of conditioned air is available, it may be used to supply conditioned air directly to the cabin distribution system, eliminating the need for pack operation.

Pack Non-Normal Operation

Pack control, fault detection, and overheat protection are all automatic. When an overheat or other significant pack fault is detected, the pack automatically shuts down. The EICAS advisory message **PACK (L, R)** is displayed. An attempt to restore pack operation may be made by pressing the AIR CONDITIONING RESET switch.

Standby Cooling Mode

For certain internal malfunctions, a pack automatically enters the standby cooling mode. In the standby cooling mode, the pack automatically shuts down at lower altitudes and higher outside air temperatures when ambient conditions do not permit standby cooling. The pack automatically restarts when altitude and outside air temperatures are suitable for the standby cooling mode.

During standby cooling mode operation, the EICAS advisory message **PACK MODE (L, R)** is displayed, and **STBY COOLING** is displayed in amber on the Air Synoptic. If both packs are in standby cooling mode, or if one pack is inoperative and the other pack is in standby cooling mode, then the packs operate continuously, regardless of altitude or outside air temperature, to maintain cabin pressurization. Decreased pack cooling capacity may result in warm flight deck or cabin temperatures at lower altitudes.

Operation With Complete Loss Of Cabin Temperature Controllers

With dual cabin temperature controller failures, or with a loss of all engine and APU electrical power, the air supply and cabin pressurization controllers control the pack flow control valves. The pack flow rate is modulated to keep pack outlet temperature between 40° and 110°F. All flight deck temperature controls are disabled except the **PACK** switches.

Air Distribution

Hot trim air from the bleed air system is added to the pack conditioned air to control the temperature in each zone. Each trim air system supplies three zone supply ducts, with the left trim air system also supplying the flight deck.

Recirculation fans add to cabin ventilation, permitting the packs to be operated at reduced flow. The flight deck receives 100% fresh conditioned air from the left pack only, and is maintained at a slightly higher pressure than the passenger cabin. This prevents smoke from entering the flight deck.

Air moves from the passenger cabin to the lower deck, where it is either exhausted overboard through outflow valves or drawn into the lower recirculation system. Air from the lower recirculation fans is mixed with pack air before entering the supply ducts. Air from the upper recirculation fans feeds into the supply ducts directly. The recirculation fans can be turned off for several minutes to provide a more rapid exchange of air.

Selecting one or more RECIRCULATION FAN switches OFF displays the EICAS memo message **RECIRC FANS OFF**. Approximately one percent fuel consumption increase occurs for each fan switch turned OFF.

Temperature Control

The cabin temperature controllers regulate the temperature by controlling the addition of hot trim air to the seven zone supply ducts through the trim air valves.

The cabin temperature controllers automatically compensate for temperature changes as cabin air humidity and passenger activity decrease during a flight.

The target temperatures are increased slowly for a period of time during cruise so the flight crew does not have to manually increase the master temperature. Temperature is decreased slowly during descent until all automatically added corrections are removed.

The flight crew can set the master passenger cabin temperature control reference to between 65° and 85°F using the CABIN TEMPERATURE control. The flight attendants can use the cabin management system to further adjust the temperature in any passenger cabin zone (+/-10°F, within the limits of 65° to 85°F). The temperature of the zone requiring the coolest temperature controls the pack outlet temperature. With the loss of inputs from the flight deck or cabin temperature controls, the packs maintain a cabin temperature of 75°F.

The flight deck temperature selector sets the flight deck temperature to between 65° and 85°F. The flight deck temperature can be controlled manually by setting the flight deck temperature selector to the manual mode.

Crew Rest Area Temperature Control

Crew rest area temperature can be controlled manually by the heater controls in the compartment.

Temperature Control With Loss Of Trim Air System

During operation with a left or right trim air system off, the cabin temperature controllers attempt to maintain all zones at the average target temperature. Setting a cooler or warmer master cabin temperature using the cabin temperature control may assist in achieving a cooler or warmer flight deck temperature as desired.

Shoulder And Foot Heaters

Flight crew shoulder heat is provided by electric elements in the side window air diffusers. The foot heaters have electric heating elements only, with no airflow. Both are available in flight only.

Lavatory And Galley Ventilation

Two ventilation fans, a primary and a backup, draw air from the galleys and lavatories. The fans operate automatically. If the primary fan fails, the backup fan automatically operates.

Conditioned air is provided to the galleys from the air distribution system.

Cargo Temperature Control System

Cargo Heat System

The aft and bulk cargo compartments each have independent bleed air heating systems. An insulated curtain separates the two compartments.

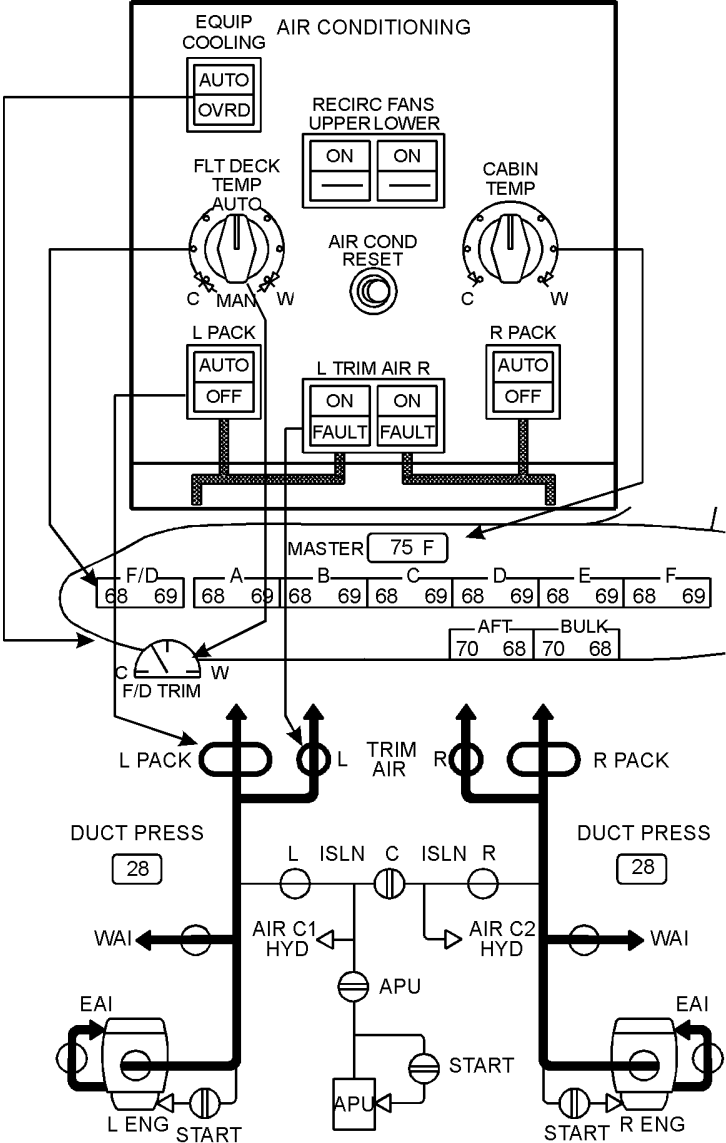
With the CARGO TEMPERATURE selector set to LOW or HIGH, the associated cargo heat shutoff valve opens and the temperature control valve (located downstream) opens and closes depending on the temperature in the compartment. The lavatory/galley vent fans draw air across temperature sensors in each compartment. If both vent fans fail, cargo heat fails.

With the CARGO TEMPERATURE selector set to LOW and TAT less than 45°F, the respective temperature control valve opens. The compartment temperature is maintained between 40° and 50°F.

With the CARGO TEMPERATURE selector set to HIGH and TAT less than 70°F, the respective temperature control valve opens. The compartment temperature is maintained between 65° and 75°F.

Selecting the HIGH setting on the BULK CARGO TEMPERATURE selector turns on the bulk ventilation fan, which is provided for animal carriage. The system has automatic overheat protection. When an automatic overheat shutdown occurs, cargo heat to the related compartment cannot be restored in flight. The EICAS advisory message **CARGO HEAT (AFT or BULK)** notifies the flight crew if a shutdown occurs or if a selector is off.

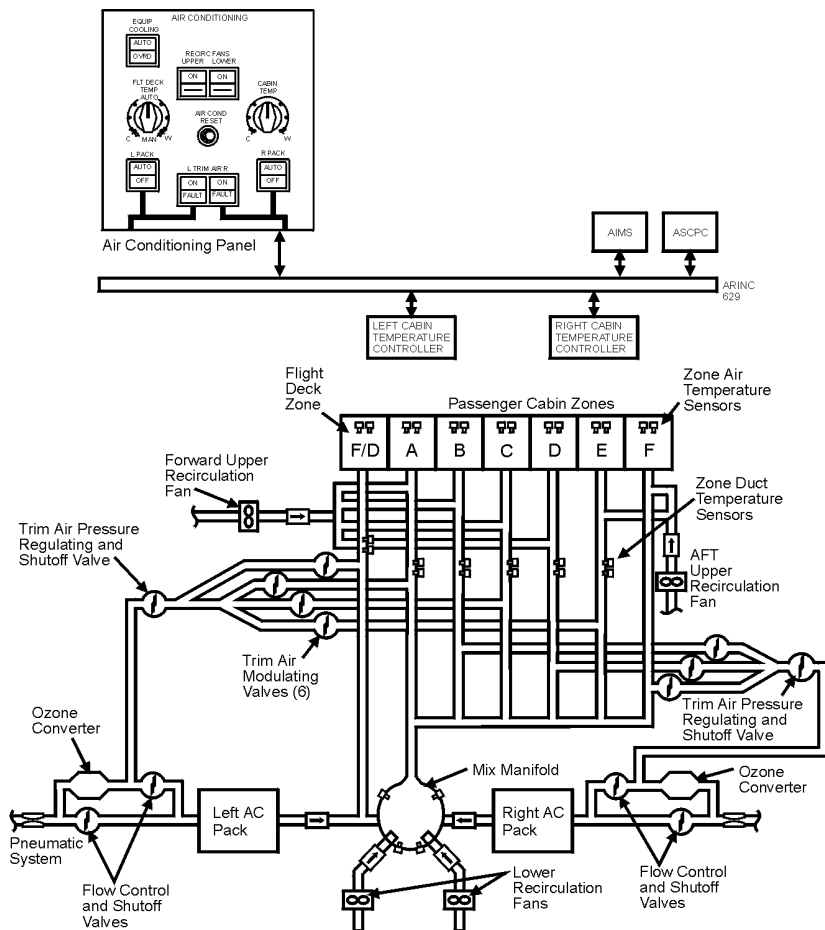
The forward cargo compartment is heated by warm air from the forward equipment ventilation system.



F/D - flight deck
ISLN - isolation valve
WAI - wing anti-ice valve
EAI - engine anti-ice valve

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AIR CONDITIONING SYSTEM SCHEMATIC



AIR CONDITIONING SYSTEM - AIR DISTRIBUTION

Forward Equipment Cooling

Forward equipment cooling supplies cooling air to the equipment in the lower forward pressurized section and the flight deck (display units and panels). The system has two supply fans. One fan operates at a time. The other fan automatically comes on if the operating fan fails.

The operating equipment cooling supply fan draws cooling air from around the forward cargo compartment and forces it through the equipment racks and flight deck equipment.

If the forward equipment cooling system is inoperative, the EICAS advisory message **EQUIP COOLING** is displayed and the ground crew call horn in the wheel well is activated. The **EQUIP COOLING** message can only display on the ground.

Forward Equipment Ventilation

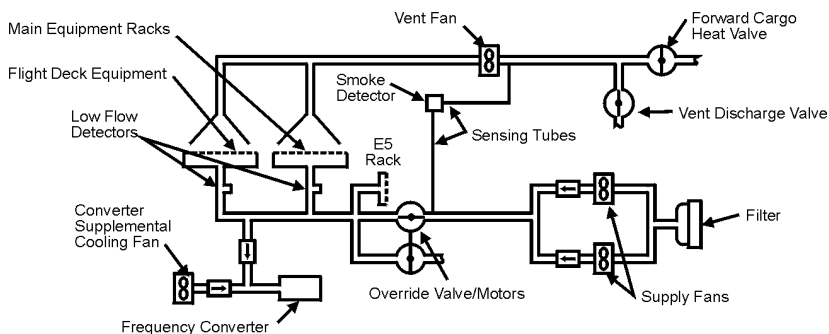
A vent fan provides forward equipment ventilation. This fan extracts hot air, created as a result of normal equipment cooling operations, from the E&E bay and the flight deck overhead panels. This air is then discharged into the forward cargo compartment. If on the ground and the forward cargo compartment does not require additional heat (TAT above 55°F) the air is discharged overboard through the forward outflow valve.

Aft Equipment Cooling

Aft equipment cooling is part of the lavatory and galley ventilation system. It provides draw-through cooling and ventilation for:

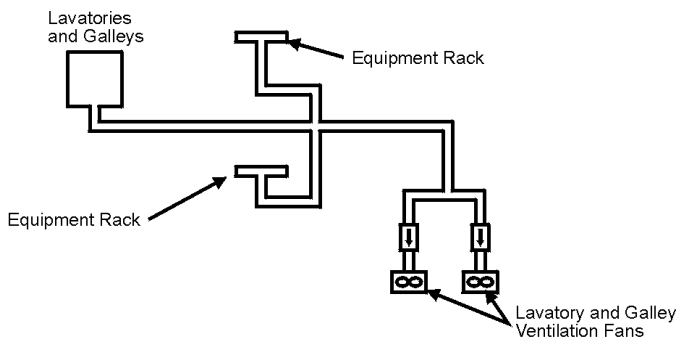
- The aft equipment racks and passenger cabin overhead equipment racks
- Passenger cabin videotape and computer equipment
- The lavatories and galleys.

The system has two lavatory/galley vent fans. One fan operates at a time. The other fan automatically comes on if the operating fan fails. The air is discharged through the aft outflow valve.



FORWARD EQUIPMENT COOLING SYSTEM

7777011



AFT EQUIPMENT COOLING SYSTEM

7777012

Smoke Evacuation

In flight, smoke evacuation of the flight deck and equipment cooling of the lower forward pressurized section is provided by the equipment cooling system override mode. This alternate mode is selected automatically:

- If smoke is detected in the forward cargo compartment
- If smoke is detected in the equipment cooling or equipment ventilation ducts
- Both supply fans fail in the forward equipment cooling system
- Low flow is detected in flight, or
- Manually commanded by the equipment cooling switch.

All supply and vent fans turn off, the smoke/override valve opens, and cabin pressure differential is used to reverse the airflow and pull the smoke through the system and equipment and discharge it overboard. The override mode supplies adequate cooling while the airplane is in cruise, but the airflow decreases as the airplane descends due to the decrease in cabin pressure differential.

PRESSURIZATION SYSTEM

Introduction

Cabin pressurization is controlled by adjusting the discharge of conditioned cabin air through the outflow valves.

Two outflow valves are installed: forward and aft. Normally, most of the outflow is through the aft outflow valve. This improves ventilation and smoke removal. The valves are identical and during normal operations, either is capable of full airflow and pressurization control. However, if either valve fails full open loss of pressurization control will occur.

Two positive pressure relief valves and four negative pressure relief doors protect the fuselage against excessive pressure differential.

The pressurization system has automatic and manual operating modes.

Automatic Operation

The pressurization system is in the automatic mode when the OUTFLOW VALVE switches are set to AUTO.

In the automatic mode, the pressurization system uses ambient pressure from the air data inertial reference system in conjunction with flight plan data from the flight management computer (FMC) to calculate the cabin pressurization schedule. This provides a comfortable cabin climb to cruise altitude.

For takeoff, the system supplies a small positive pressurization to cause a smooth cabin altitude transition. During climb, cabin altitude increases on a schedule related to the airplane climb rate and flight plan cruise altitude.

When maximum cabin differential pressure is reached, cabin climb rate becomes a function of airplane climb rate, while maintaining the maximum differential pressure. This results in a cabin altitude of 8,000 feet at the maximum certified operating altitude.

When the vertical path has a planned level segment as a part of the selected departure, it is included in the total time required for the airplane to reach the top of climb. The cabin climb rate is adjusted and continues to increase cabin altitude during the level segment.

During descent, cabin altitude decreases to slightly below the FMC planned landing altitude. This ensures that the airplane lands pressurized. Landing altitude barometric pressure correction comes from the captain's altimeter setting.

At touchdown, both outflow valves open to depressurize the cabin.

For high altitude takeoffs, if the takeoff field elevation is higher than 8,000 feet, the cabin descends to the target altitude while the airplane is climbing.

For high altitude landings, if the destination airport elevation is greater than 8,000 feet, the cabin altitude climbs to 8,000 feet after takeoff and remains there during cruise. The cabin altitude will then start climbing to the destination airport elevation when appropriate.

Manual Operation

The pressurization system is in the manual mode when the OUTFLOW VALVE switches are set to MAN.

The system is manually operated by:

- Setting the OUTFLOW VALVE switches to MAN
- Holding the related OUTFLOW VALVE MANUAL switch to OPEN or CLOSE.

Outflow valve position is displayed on the EICAS display. If the outflow valve position is not available on EICAS, holding the respective OUTFLOW VALVE MANUAL switch in the desired position for 30 seconds will move the valve from full open or close to the selected position.

Landing altitude (normally provided by the FMC) can be manually set using the LANDING ALTITUDE selector. Landing field selection limits are 2,000 feet below sea level to 14,000 feet above sea level. Pulling the selector out to the detent removes the FMC landing altitude and displays pressurization system indications on the EICAS display. The knob is rotated clockwise to increase or counterclockwise to decrease the landing altitude setting. Two rates of increase or decrease, low and high, are available in each direction from the spring-loaded center position.

Operation With Loss Of Cabin Pressurization

With a sudden loss of cabin pressurization, the outflow valves will close immediately in an attempt to control the cabin pressure. After descent, when the aircraft and cabin altitudes are approximately equal, the outflow valves open to protect the aircraft against negative pressure differentials.

It is important that the flight crew not attempt to manually close the outflow valves during the descent.

BLEED AIR SYSTEM

Introduction

Bleed air can be supplied by the engines, APU, or a ground air source.

Bleed air is used for:

- Air conditioning
- Pressurization
- Wing and engine anti-ice
- APU and engine start
- Aft cargo heat
- Air driven hydraulic pumps
- Hydraulic reservoir pressurization
- Potable water tank pressurization
- TAT probe aspiration.

Engine Bleed Air Supply

Engine bleed air comes from either the high stage or the low stage engine sections. Low stage air is used during high power setting operations. High stage air is used during descent and other low power setting operations.

The engine bleed air valves are armed when the ENGINE bleed switches are selected ON. The valves are pressure actuated and remain closed until engine bleed air pressure is sufficient to cause forward flow. The engine bleed valves close automatically:

- During start
- For bleed source loss
- For bleed air overtemperature
- For bleed air overpressure
- For a bleed air duct leak
- When an engine fire switch is pulled
- When a ground cart is supplying air.

APU Bleed Air Supply

APU bleed air is used primarily during ground operations for air conditioning pack operation and engine starting. In flight, APU bleed air is available below approximately 22,000 feet.

The check valve in the APU supply line prevents reverse flow of bleed air from the duct into the APU.

Ground Bleed Air Supply

External connectors are provided to connect a ground source of high pressure air directly to the bleed air duct.

Check valves prevent reverse flow of bleed air from the bleed air duct to the connectors.

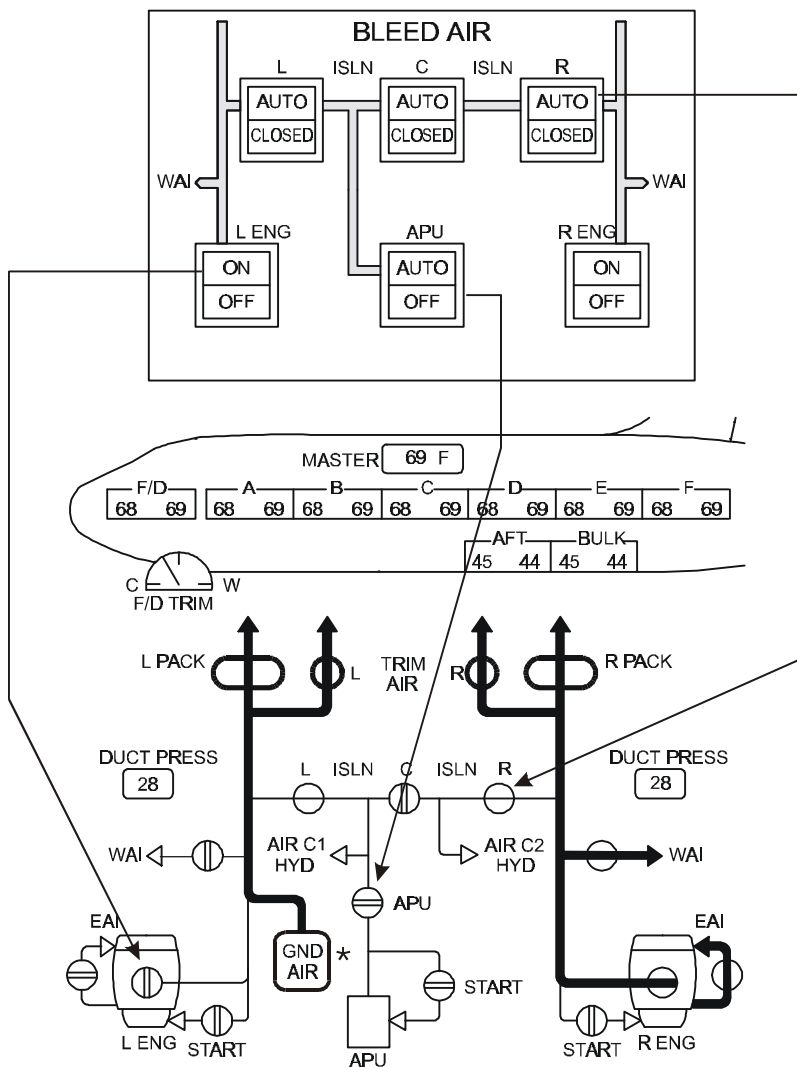
Bleed Air Duct System

The left, center, and right isolation valves separate the bleed air duct into isolated segments. The automatic system operates with the left and right isolation valves normally open. The center isolation valve is normally closed, except for engine start or single bleed source operation.

Duct Leak And Overheat Detection System

If a duct leak is detected, the system automatically isolates the leak. The EICAS caution message **BLEED LEAK** is displayed. The isolation process may require one, two, or three automatic steps. During the isolation process, the ENGINE and/or APU bleed switch **OFF** lights and the ISOLATION switch **CLOSED** lights illuminate and extinguish as the valves close and open.

When the temperature in the affected duct area cools, the **BLEED LEAK** EICAS message is removed. The valves isolating the leak remain closed and the appropriate **BLEED LOSS** EICAS message is displayed. The switch **OFF** or **CLOSED** lights show which valves remain closed to isolate the affected duct area.



*Displayed when connected

F/D - flight deck

ISLN - isolation valve

WAI - wing anti-ice valve

EAI - engine anti-ice valve

7777002

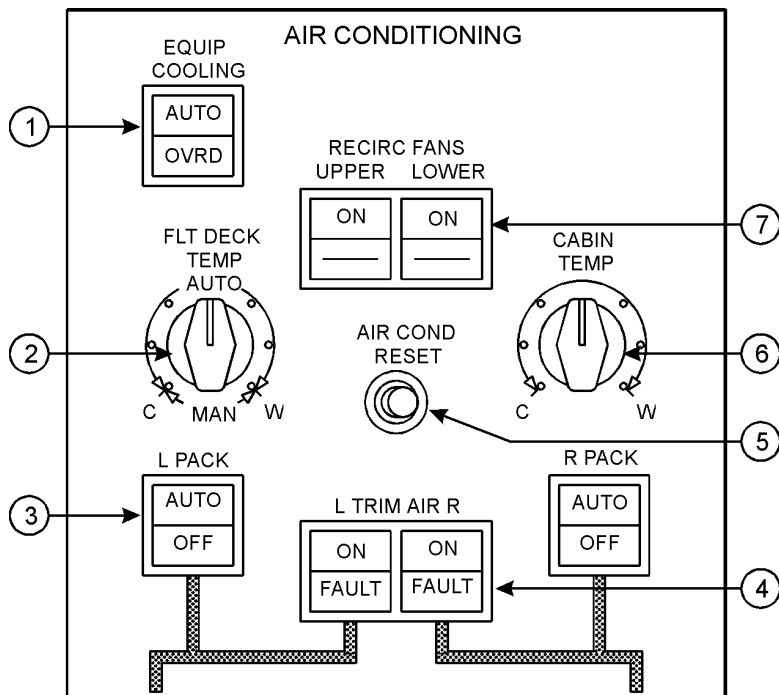
BLEED AIR SYSTEM SCHEMATIC

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CONTROLS AND INDICATORS

AIR CONDITIONING SYSTEM

Air Conditioning Panel



OVERHEAD PANEL

7777004

① Equipment Cooling (EQUIP COOLING) Switch

AUTO - Equipment cooling mode is controlled automatically.

Off (AUTO not visible) -

- Both equipment cooling supply fans are not operating
- The smoke/override valve is open
- The forward cargo heat valve is closed, and
- **OVRD** illuminates.

OVRD (override) illuminated (amber) - SMOKE/OVRD mode is operating because:

- Off is selected manually
- Both equipment cooling supply fans fail, or
- The smoke/override mode is automatically selected by the smoke detection system.

② Flight Deck Temperature (FLT DECK TEMP) Control

AUTO -

- Provides automatic temperature control for the flight deck
- Turning the control toward C or W sets the desired temperature between 65°F and 85°F. Mid position (12 o'clock) sets approximately 75°F.

MAN (manual) -

- Provides manual control of the flight deck trim air modulating valve
- Turning the control from the MAN position to the C detent drives the flight deck trim air modulating valve toward closed to provide cooler air
- Turning the control from the MAN position to the W detent drives the flight deck trim air modulating valve toward open to provide warmer air.

③ PACK Switches

AUTO - The pack is automatically controlled.

OFF (AUTO not visible) - The pack flow control valves are commanded closed.

OFF illuminated (amber) - The pack flow control valves are commanded closed:

- Automatically during engine start
- Automatically due to a pack or compressor outlet high temperature, both flow control valves failed closed, no pneumatic air, or
- OFF is manually selected.

④ TRIM AIR Switches

ON - The trim air valve is commanded open.

Off (ON not visible) -

- The trim air valve is commanded closed, and
- **FAULT** illuminates.

FAULT illuminated (amber) -

- The trim air valve is failed closed
- The trim air valve is commanded closed because of a zone supply duct overheat, or
- The TRIM AIR switch is selected off.

⑤ Air Conditioning Reset (AIR COND RESET) Switch

Push -

- Resets any closed pack flow control valves or trim air valves held closed due to overheat, control failure, or valve failure
- Attempts to reset a failed recirculation fan
- Resets fault protection.

⑥ Cabin Temperature (CABIN TEMP) Control

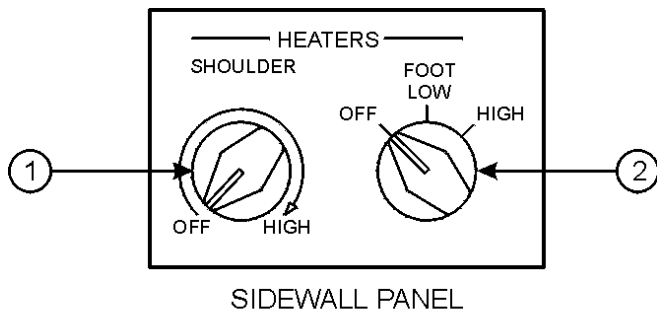
Provides automatic passenger cabin temperature control.

Turning the control toward C or W sets the passenger cabin master reference temperature between 65 degrees F and 85 degrees F.

⑦ Recirculation Fans (RECIRC FANS) Switches

ON - Provides automatic operation of the associated recirculation fans.

Off (ON not visible) - The selected recirculation fans do not operate.

Shoulder and Foot Heaters

7777003

① SHOULDER HEATER Control

OFF - the electric heater is not operating (no heat added to the conditioned air flowing at shoulder level).

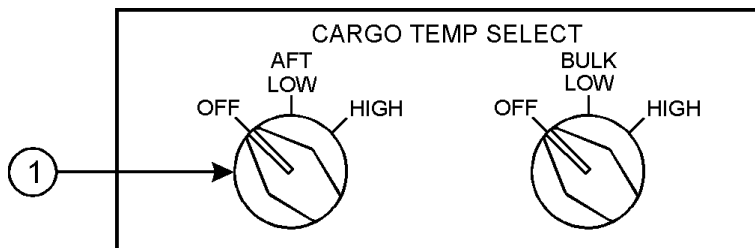
Turn - the electric heater adds heat to the conditioned air flowing in at shoulder level at variable temperature settings up to HIGH.

② FOOT HEATER Selector

OFF - The under-floor electric heater is not operating.

LOW - The under-floor electric heater operates on low setting.

HIGH - The under-floor electric heater operates on high setting.

Cargo Temperature Control**OVERHEAD MAINTENANCE PANEL**

7777005

① CARGO TEMPERATURE Selectors

OFF - Shuts off bleed air to the compartment.

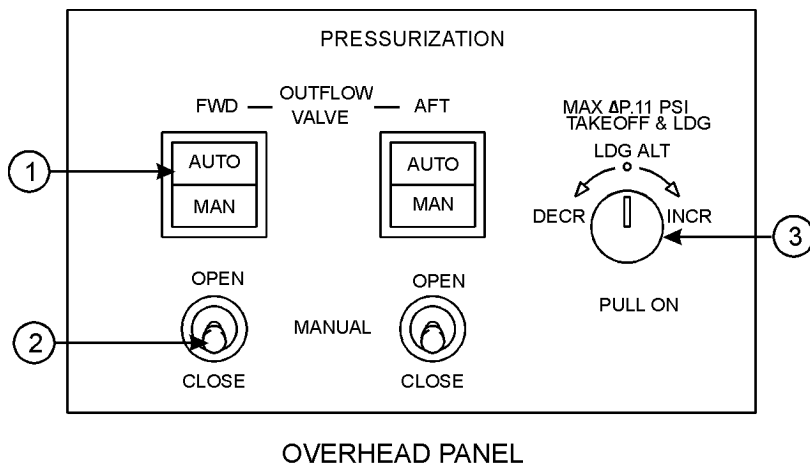
LOW - The compartment temperature is automatically kept at low temperature (approximately 45°F).

HIGH - The compartment temperature is automatically kept at high temperature (approximately 70°F). For the bulk compartment only, the bulk compartment ventilation fan operates continuously.

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PRESSURIZATION SYSTEM

Pressurization Panel



7777006

① OUTFLOW VALVE Switches

AUTO - Outflow valve position is automatically controlled.

Manual (AUTO not visible) -

- Outflow valve position is controlled by the OUTFLOW VALVE MANUAL switch
- **MAN** illuminates
- Outflow valve position is displayed on EICAS (an amber **M** is displayed on the outflow valve position indicator on EICAS).

MAN (manual) illuminated (amber) - Outflow valve position is controlled by the associated OUTFLOW VALVE MANUAL switch.

② OUTFLOW VALVE MANUAL Switches

Spring-loaded to center.

Controls outflow valve position when **MAN** is illuminated in the OUTFLOW VALVE switch.

OPEN - Moves the outflow valve toward open.

CLOSE - Moves the outflow valve toward closed.

③ Landing Altitude (LDG ALT) Selector

Pull ON, then turn -

- Overrides FMS landing altitude inputs to the cabin altitude controllers
- Landing altitude must be set manually
- Landing altitude is displayed on the lower portion of the EICAS display (followed by **MAN**)
- Landing altitude display changes in 100 foot increments at the first detent, 500 foot increments at the second detent.

Push -

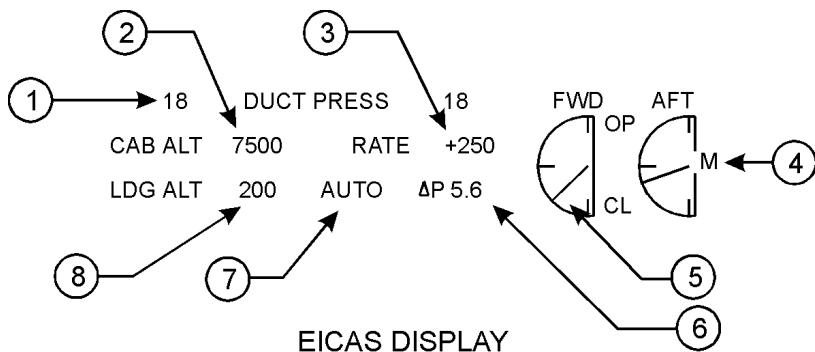
- Landing altitude is automatically input to the cabin altitude controllers from the FMC
- Landing altitude is displayed on the lower portion of the EICAS display (followed by **AUTO**).

Pressurization System Indications

Pressurization system indications are displayed automatically when:

- The LANDING ALTITUDE selector is pulled ON
- An OUTFLOW VALVE switch is selected to MAN
- Cabin altitude is above normal range (amber)
- EICAS **CABIN ALTITUDE** message is displayed (red)
- Cabin differential pressure is above normal range (amber)
- Cabin differential pressure is excessive (red)
- Duct pressure is below normal range (amber) with the respective engine running

- The AIR synoptic is displayed on any MFD
- The following EICAS messages are displayed:
 - CABIN ALTITUDE AUTO
 - LANDING ALTITUDE
 - OUTFLOW VALVE FWD
 - OUTFLOW VALVE AFT.



7777007

① Duct Pressures

- Pounds per square inch (PSI).
- Normal operating range (white).
- Below normal range (amber).

② Cabin Altitude

- Feet.
- Normal operating range (white).
- Above normal range (amber).
- With EICAS **CABIN ALTITUDE** message displayed (red).

③ Cabin Altitude Rate

- Feet per minute.
- Plus (+) - rate of climb of cabin altitude.
- Minus (-) - rate of descent of cabin altitude.

④ Outflow Valve Manual Indication

- M (manual) (amber) - manual control.
- Blank - automatic control.

⑤ Outflow Valve Position Indications

- OP - open.
- CL - closed.

⑥ Cabin Differential Pressure

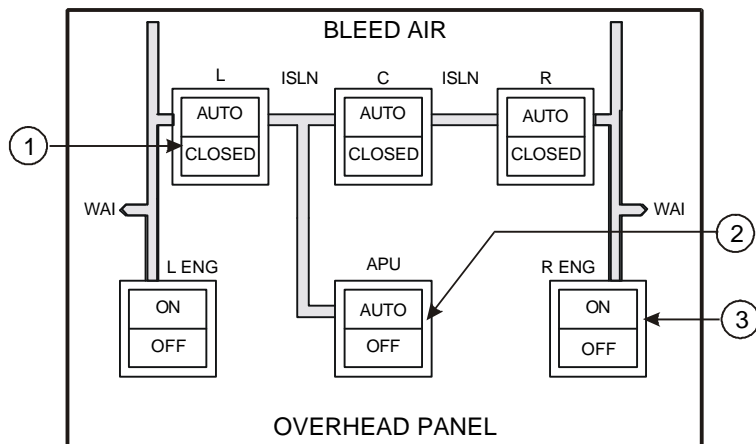
- Pounds per square inch (PSI).
- Normal operating range (white).
- Above normal range (amber).
- Excessive differential pressure (red).

⑦ Landing Altitude Mode

- AUTO (automatic) (white) - altitude is automatically supplied by the FMC.
- MAN (manual) (amber) - altitude is manually selected using the LANDING ALTITUDE selector.

⑧ Landing Altitude

- Feet.
- Landing altitude supplied by the FMC or manually selected using the LANDING ALTITUDE selector.
- Blank - display is blank without valid FMC landing altitude.

BLEED AIR SYSTEM

7777008

① Bleed Isolation (ISLN) Switches

AUTO - The bleed isolation valve is automatically controlled.

Off (AUTO not visible) - Manually commands the respective bleed isolation valve to close.

CLOSED illuminated (amber) -

- The isolation valve is closed due to a duct leak or bleed loss
- The valve is closed because the switch is selected to off, or
- The valve fails closed.

② APU Bleed Switch

AUTO - The APU bleed air valve is automatically controlled.

OFF (AUTO not visible) - The valve is commanded closed.

OFF illuminated (amber) - The APU bleed air valve is closed:

- Automatically due to a duct leak
- Because the switch is selected OFF
- Due to the valve failing closed
- Because the APU fire switch is pulled out.

③ Engine (ENG) Bleed Switches

ON - The engine bleed valves open when engine bleed air is available.

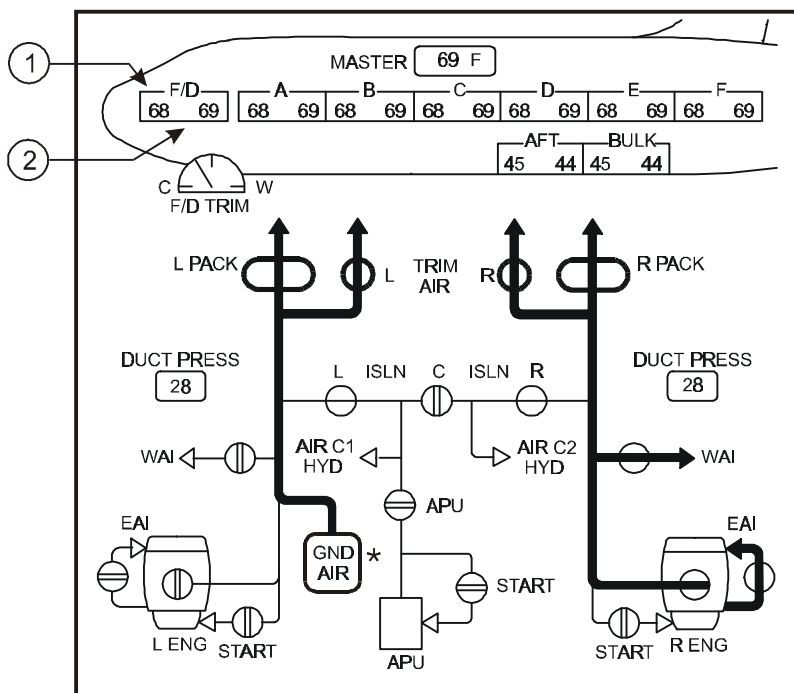
OFF (ON not visible) - Valve is manually commanded closed.

OFF illuminated (amber) - The engine bleed valves are closed:

- Automatically due to a protective bleed shut down or duct leak
- Because the switch is selected OFF
- Because the engine is not running, or
- Because the engine fire switch is pulled out.

AIR SYNOPTIC DISPLAY

The air systems synoptic is displayed by pushing the AIR synoptic display switch on the display select panel. Display select panel operation is described in Section 6.10, Flight Instruments, Displays.



*Displayed when connected

F/D - flight deck

WAI - wing anti-ice valve

ISLN - isolation valve

EAI - engine anti-ice valve

MULTIFUNCTION DISPLAY

7777009

- ① Selected Temperatures (magenta)

Selected by the FLT DECK TEMP and the CABIN TEMP controls.

- ② Actual Temperatures (white)

Actual temperature sensed on the flight deck or the passenger zone.

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Air Systems EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
BLEED ISLN CLOSED C, L, R	Advisory		Isolation valve remains closed when commanded open or bleed isolation switch is OFF.
BLEED ISLN OPEN C, L, R	Advisory		Isolation valve remains open when commanded closed.
BLEED LEAK BODY	Caution	Beeper	High temperature bleed air leak is detected in the body area.
BLEED LEAK L, R	Caution	Beeper	High temperature bleed air leak is detected in the wing or pack bay area.
BLEED LEAK STRUT L, R	Caution	Beeper	High temperature bleed air leak is detected in the strut area.
BLEED LOSS BODY	Advisory		Bleed air from the left and right body ducts is no longer available.
BLEED LOSS BODY L, R	Advisory		Bleed air from the body duct is no longer available.
BLEED LOSS WING L, R	Advisory		Bleed air from the wing duct is no longer available.
BLEED OFF APU	Advisory		APU bleed valve is closed for a system fault or APU bleed switch is OFF.
BLEED OFF ENG L, R	Advisory		Engine bleed valve is closed for a system fault or engine bleed switch is OFF.
CABIN ALTITUDE	Warning	Siren	Cabin altitude is excessive.
CABIN ALTITUDE AUTO	Caution	Beeper	Automatic pressurization control has failed or both outflow valve switches are in manual.

Message	Level	Aural	Condition
CARGO HEAT AFT, BULK	Advisory		Cargo heat is inoperative or cargo temperature selector is OFF.
EQUIP COOLING	Advisory		Forward equipment cooling is inoperative.
EQUIP COOLING OVRD	Advisory		Equipment cooling system is in override mode.
LANDING ALTITUDE	Advisory		FMC has failed to provide a landing altitude or landing altitude selector is pulled.
OUTFLOW VALVE AFT, FWD	Advisory		Automatic control has failed or outflow valve switch is in MAN.
PACK L, R	Advisory		Pack is shut down.
PACK MODE L, R	Advisory		Pack is operating in standby mode.
RECIRC FANS OFF	Memo		One or both recirculation fan switches are in the off position.
TRIM AIR L, R	Advisory		Trim air is shut off.

LIST OF EFFECTIVE PAGES

PAGE	DATE	PAGE	DATE	PAGE	DATE
* TOC-1	11/01/02	31	11/01/00		
* TOC-2	11/01/02	32	11/01/00		
1	11/01/00	* LEP-1	11/01/02		
2	11/01/00	* LEP-2	11/01/02		
3	11/01/00				
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